IPART
New South Wales

Independent Pricing and Regulatory Tribunal

Method Guide
Project Impact Assessment with Measurement and Verification Method

Energy Savings Scheme
November 2016

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Document control

Version number	Change description	Date published
V1.0	Initial release – following gazettal of ESS Rule Amendment no. 2	8 January 2015
V2.0	Application Form: Part B and Evidence Package removed from the Method Guide to be separate documents.	10 February 2015
V2.1	Revised statement regarding additional application documentation.	6 May 2015
V3.0	Updates following amendments to the ESS Rule commencing on 15 April 2016	May 2016
V3.1	Updates to include additional technical guidance (Appendices D and E) and a number of minor amendments	November 2016

Contents

1 About this document

The NSW Energy Savings Scheme (**ESS**) seeks to reduce energy consumption in NSW by creating financial incentives for organisations to invest in energy saving projects.

The other objects of the ESS are to:

- assist households and businesses to reduce energy consumption and energy costs
- make the reduction of greenhouse gas emissions achievable at a lower cost, and
- reduce the cost of, and need for, additional energy generation, transmission and distribution infrastructure.[1]

Electricity retailers and other mandatory participants (**Scheme Participants**) are obliged to meet energy saving targets. Energy savings can be achieved by installing, improving or replacing energy saving equipment. Persons that become Accredited Certificate Providers (**ACPs**) can create energy savings certificates (**ESCs**) from these activities and then sell those ESCs to Scheme Participants. The Independent Pricing and Regulatory Tribunal of NSW (**IPART**) is both the Scheme Administrator and Scheme Regulator of the ESS.[2]

This document provides guidance about how the Project Impact Assessment with Measurement and Verification (**PIAM&V**) method of the ESS operates, some of the key requirements that must be met when using the method, and how to calculate energy savings for a Recognised Energy Saving Activity (**RESA**) and create ESCs. This document should be used by:

- applicants seeking accreditation as a certificate provider, to assist them in completing their application,[3] and
- those persons who are already ACPs, to assist them in accurately calculating energy savings using this method.

Specifically, this guide provides information on the calculation of energy savings and creation of ESCs using clause 7A of the ESS Rule[4] for:

- forward creation of ESCs from a single site model calculated from a Baseline Energy Model and Operating Energy Model (modelling energy performance before and after project implementation)[5] (section 4.1 of this guide)

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1 *Electricity Supply Act 1995*, section 98(2)

2 *Electricity Supply Act 1995*, sections 153(2) and 151(2)

3 A full explanation of the application process is provided in the Application Guide www.ess.nsw.gov.au/How_to_apply_for_accreditation/Apply_now_-_guides_and_application_forms. Please ensure you read this document and the Application Guide in full before applying for accreditation.

4 *Energy Savings Scheme Rule of 2009*, as amended from time to time.

- annual creation or top-up of ESCs based on actual performance of a project following implementation, and compared to a Baseline Energy Model (sections 4.2 and 4.3 of this guide), and
- multiple site ESC creation based on a multiple site model, and using a sampling method (section 5 of this guide).

In addition to this guide, the following references are recommended reading when using this method:

- the Measurement and Verification Operational Guide published by the NSW Office of Environment and Heritage (**OEH**),[6] and
- the International Performance Measurement and Verification Protocol, Concepts and Options for Determining Energy and Water Savings, Volume I, 2012 (**IPMVP**), published by the Efficiency Valuation Organization.[7]

1.1 Legislative requirements

This document is a guide only and is not legal advice. The legal requirements for ACPs participating in the ESS are set out in:

- Part 9 of the *Electricity Supply Act 1995* (**Act**)
- Part 6 of the *Electricity Supply (General) Regulation 2014* (**Regulation**), and
- the *Energy Savings Scheme Rule of 2009* (**ESS Rule**).

ACPs are also required to meet any additional conditions as set out in their Accreditation Notice.

Major amendments were made to the ESS Rule on 15 April 2016. The information in this document reflects the requirements of the current version of the ESS Rule and should be referred to for all implementations from that date.

ACPs who calculated energy savings under the previous version of the ESS Rule, in accordance with clause 11.1 of the ESS Rule, should refer to version 2.1 of this document.[8]

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5 A RESA may involve multiple sites, where each site has its own energy model.
6 Available at www.environment.nsw.gov.au. Refer to Appendix D for further information.
7 Available at www.evo-world.org
8 Refer: www.ess.nsw.gov.au/Methods_for_calculating_energy_savings/Document_archive

2 Method overview

The PIAM&V method requires the measurement and verification of energy savings from implementing equipment that is more energy-efficient than the original equipment being replaced, or from modifying the existing equipment to improve its energy efficiency. It also allows new end-user equipment to be installed where the specific conditions of the ESS Rule are met.[9]

By using measurement and verification techniques to predict and then verify energy savings, the method can assist decision-makers to evaluate funding proposals and make investment decisions. The method accounts for changes in operating conditions, which means that energy savings from different activities can be reasonably compared.

A key feature of this method is that it allows energy savings to be calculated (deemed)[10] for a maximum period of 10 years after the implementation date. Discounting is applied to the calculated energy savings based on the quality of the measured data and how well it fits with predicted energy models. The discounted energy savings are then used to forward create ESCs for up to 10 years.

ESCs that are forward created can also be 'topped-up'[11] yearly if additional energy savings beyond those calculated from forward creation can be demonstrated. For more information on topping-up, see section 4.2 of this guide.

2.1 Types of energy models

There are four acceptable types of energy models that may be used to model the energy use and calculate energy savings:[12]

- *Estimate of the Mean*: to be based on measurements of energy consumption, independent variables and site constants (where relevant), and specifying a measurement period. The coefficient of variation of the energy consumption over the measurement period must be less than 15%.

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9 *ESS Rule*, cl 5.3B

10 'Deeming' refers to the fact that the energy savings for the entire period (e.g. 10 years) are deemed to occur under the ESS Rule at the time of implementation, and therefore ESCs can be created from those energy savings as from that time.

11 'Topping-up' refers to ACPs being able to create ESCs in addition to the ESCs created from the original calculation for the deemed energy savings. These 'top-up' ESCs are created from the difference between the actual energy savings that are verified at the end of each year through ongoing measurement, and those used to create the ESCs from the original calculation.

12 *ESS Rule*, cl 7A.2

- *Regression Analysis*: to be based on measurements of energy consumption, independent variables and site constants and specifies a measurement period. The number of independent observations for the independent variables must be at least six times the number of model parameters in the energy model.
- *Computer Simulation*: must use a commercially available software package approved by the Scheme Administrator for use in modelling the relevant type of end-user equipment, and that is calibrated against measurements taken from the actual end-user equipment being simulated to meet any requirements as published by the Scheme Administrator.
- *Sampling Method*: based on measurement and estimate of the mean, regression analysis or computer simulation of similar end-user equipment at similar sites, and meets any requirements published by the Scheme Administrator.

  Note that clause 7A.1(c) of the ESS Rule stipulates that the sampling method may only be used by ACPs that were accredited either on or before 15 April 2016.

2.2 Calculating gas savings

For implementations on or after 15 April 2016 the PIAM&V method may be used to calculate either electricity savings or gas savings or both. Where both gas and electricity savings are being calculated, different energy models must be created for each energy type. The term 'energy savings' is used throughout this document and means electricity savings or gas savings or both.

Under clause 5.3(e)(ii) of the ESS Rule, a gas efficiency project may be an eligible activity if it increases the efficiency of gas consumption, where the gas is combusted for stationary energy.

Under clauses 5.3(e)(iii) and 5.4(j) of the ESS Rule, fuel switching from electricity to gas, or gas to electricity may be an eligible activity if (all other requirements being met) it:

- increases the efficiency of the overall energy consumption at the site, and
- does not increase greenhouse gas emissions.

Where a project involves a fuel switching activity, greenhouse gas emissions must be calculated using electricity savings, gas savings and full fuel cycle emissions factors and equations from the current version of the National Greenhouse Accounts Factors. More information on fuel switching can be found in Appendix C of this guide.

Measurements of gas must be made in accordance with the requirements set out in either:

- the *National Greenhouse and Energy Reporting (Measurement) Determination 2008*,[13] or
- the National Measurement Institute standard for gas meters *NMI R 137 Gas Meters*.[14]

Gaseous fuels that are eligible in the ESS are set out in the definition of 'Gas' in clause 10 of the ESS Rule.

ACPs interested in using the PIAM&V method to calculate gas savings will first need to submit an application for amendment of their conditions of accreditation to IPART to include gas saving activities in their RESA.[15]

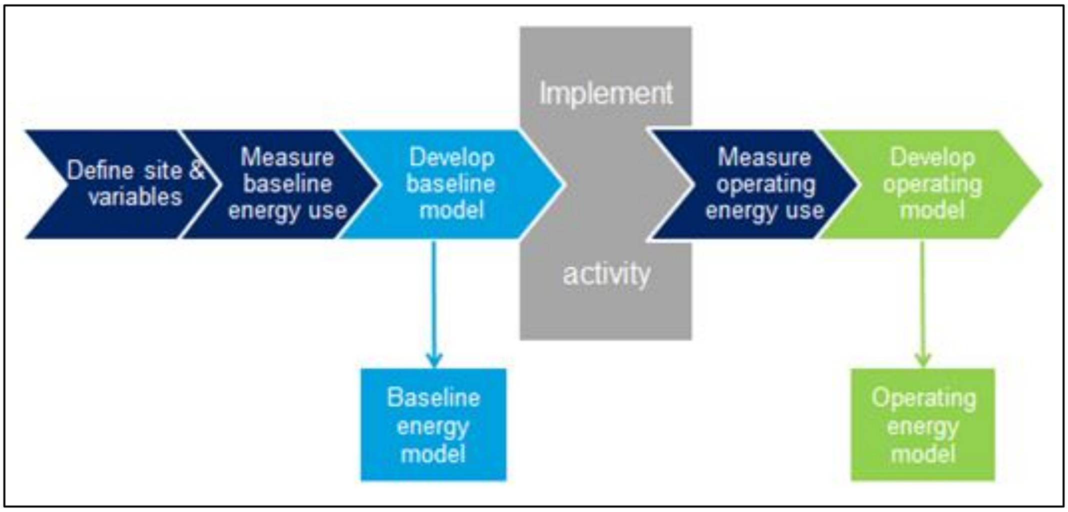
2.3 Measurement and verification method

The calculation of energy savings under this method is based on comparing the results of a baseline energy model with those from an operating energy model, as shown in Figure 2.1 below. This requires:

- baseline and operating energy use to be measured and modelled before and after an implementation, and
- independent variables and site constants to be determined and included in the energy models.

13 Refer: www.legislation.gov.au/Details/F2013C00661
14 Refer: www.measurement.gov.au/Pages/Gas-Meters-Comment-Sought-on-NMI-R-137.aspx
15 Refer: www.ess.nsw.gov.au/Accredited_Certificate_Providers/Accreditation_Notice_and_Amendments

Figure 2.1 Development of baseline and operating energy models from measurements



3 Requirements that must be met

The information below is guidance about the requirements of the method. This is not an exhaustive list of requirements, and you should ensure that you are familiar with your obligations under the Act, Regulation, ESS Rule and any conditions of your accreditation.

3.1 Energy saver

An ACP can only calculate energy savings and create ESCs from an implementation if the ACP is the 'energy saver' under the ESS Rule. The ACP must be the energy saver as at the implementation date. An energy saver can be either:

- **the original energy saver** – which, under the PIAM&V method, is the purchaser (discussed below), or
- **the nominated energy saver** – which is someone the original energy saver has nominated to be the energy saver by completing a Nomination Form using the method-specific template.[16]

An ACP that is the original energy saver must be accredited as an ACP prior to the implementation date in order to create ESCs from an implementation.

[16] The nomination must be made in a form and manner approved by the Scheme Administrator. The relevant method-specific template for nomination forms is available at www.ess.nsw.gov.au/Methods_for_calculating_energy_savings/Project_Impact_Assessment_with_MV

A nominated energy saver must have a documented procedure for obtaining the nomination from the original energy saver. The nomination is taken to occur on the date that the nomination form is signed by both the **original energy saver** and **nominated energy saver.** To create ESCs from an implementation, a nominated energy saver must be:

- **accredited** as an ACP **prior to** the implementation date and before the nomination is made,[17] and
- **nominated** by the original energy saver **on or before** the implementation date.

3.2 Purchaser

In general, the purchaser is the person who purchases or leases the goods or services that enable the relevant energy savings to be made. However, the following persons cannot be a 'purchaser' and therefore cannot be an original energy saver under the PIAM&V method:

- an ACP who is not the owner, occupier or operator of the relevant site,[18]
- a person who purchases or leases the goods or services for the purpose of reselling the end-user equipment, unless the resale will be an inclusion in a contract for the sale of land or a strata scheme lot.[19]

Box 3.1 Evidence for the energy saver

The original energy saver (purchaser) can be evidenced by a document in relation to the purchase or lease of the goods that enable the energy savings to be made, such as a tax invoice or sales ledger extract, that:

- shows the completion date and address
- identifies the recipient
- identifies the supplier (including their ABN), and
- provides a brief description of the equipment or service provided (itemised if possible).

If the ACP is a nominated energy saver they must also have a signed nomination form.

3.3 Implementation and implementation date

An implementation is the delivery of an energy saving activity (called a 'RESA' in the ESS Rule)[20] at a site. For ACPs that use the PIAM&V method, the

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17 The ESS website provides information on applying to become an ACP at www.ess.nsw.gov.au/How_to_apply_for_accreditation.

18 ACPs that are nominated Energy Savers will typically fall under this category.

19 Wholesalers will typically fall under this category.

implementation date is the date that the implementation commenced 'normal operations'.[21] Normal operations are considered to commence when the installation of the end-user equipment is complete, or when a new service commences. They may commence after a commissioning period or after fine-tuning the performance of the equipment or process. If normal operations are to commence after a commissioning period, details of the commissioning process should be included in the nomination form or other formal project documentation.

To create ESCs, an ACP must be accredited for the relevant RESA **prior to** the implementation date.[22] ACPs who create ESCs must be the energy saver as at the implementation date. ACPs who are nominated as the energy saver must be nominated by the original energy saver **on or before** the implementation date.

Box 3.2 Evidence of the implementation date

The implementation date can be evidenced by a completion/commissioning report that:

- is produced by the party responsible for the design and commissioning of the equipment
- clearly identifies the location where the implementation occurred, and
- shows the implementation date and is signed by an appropriately qualified and responsible person.

The report can be an internal document that demonstrates the completion of process improvements by internal staff.

3.4 Production and service levels

Energy savings cannot be calculated from a reduction in production or service levels. For example, closing down a manufacturing plant is not an eligible activity. However, turning off redundant machinery, whilst maintaining production or service levels, is an eligible activity.

To address this issue, production or service levels must be included as independent variables or site constants and accounted for in the energy models. Their inclusion must be done in a way that allows direct comparison of performance before and after an implementation.

[20] A RESA must meet all of the criteria set out in clause 5.3 and 5.4 of the ESS Rule.
[21] *ESS Rule*, cl 7A.17
[22] The ESS website provides information on applying to become an ACP at www.ess.nsw.gov.au/How_to_apply_for_accreditation.

Box 3.3 Evidence of maintenance of production and service levels

This can be evidenced by a document showing the calculation of a production or service metric for each site, before and after an implementation.

3.5 Efficiency requirement for installing new end-user equipment

If new end-user equipment[23] is being installed, it must be more efficient than the average energy efficiency of end-user equipment that provides the same type, function, output or service. The average energy efficiency may be estimated by reference to:

- product-weighted averages of products registered as complying with an Australian / New Zealand Standard (AS/NZS) that defines how energy efficiency is to be measured for that class of end-user equipment
- sales-weighted market data for that class of end-user equipment collected from installers, retailers, distributors or manufacturers, or
- baseline efficiency for that class of end-user equipment which may, from time to time, be published by the Scheme Administrator.

3.6 Developing an M&V Plan

To calculate energy savings using the PIAM&V method, you must develop a Measurement and Verification Plan (**M&V Plan**). Development of a detailed M&V Plan is central to the successful use of M&V for estimating energy savings.

The M&V Plan is typically used to: set out the measurement approach; explain the parameters used (and not used) in the energy models; and, to record the energy savings resulting from an activity. The OEH Measurement and Verification Operational Guide, and the IPMVP (both referenced above) provide detailed guidance on the development and use of M&V Plans. Additional guidance is also provided in Appendix D of this document. An example M&V Plan can be found in Appendix E.

For PIAM&V, the M&V Plan can be used to record how energy models meet the requirements of the ESS Rule, by including sub-headings to check off that each of the ESS Rule requirements have been addressed.

The M&V Plan should describe how each of the parameters used in energy models was derived, so that all assumptions and inputs to the calculation

[23] 'New end-user equipment' is defined as end-user equipment where no end-user equipment of the same type, function, output or service was previously in its place (but does not include additional components installed in the course of modifying existing end-user equipment).

spreadsheets[24] can be referenced and verified by the M&V Professional (see section 3.9) or at audit if required.

3.7 Developing an energy model

The ESS Rule requires that the following parameters are considered and established to support the development of the baseline and operating energy models:

- measurement boundarychoice of independent variables and site constants (for each model)[25]
- effective range, and
- implementation date.

Also, the following factors are required to determine the energy savings:

- normal year
- interactive energy savings
- accuracy factor
- decay factor, and
- counted energy savings.

More details on how each of these parameters and factors is considered and established for an implementation are provided in Appendices A and D of this guide.

The development of energy models is represented in Figure 3.2.[26] These are represented by the dashed lines across the tops of the graphs for energy consumption, which emulate the energy consumption changes in the baseline and operating periods.

The energy models must also account for *non-routine events* to ensure that a reasonable comparison can be made between the energy consumption measurements before and after an implementation. Non-routine adjustments are made to the measured data to account for unexpected changes in energy use that occur due to non-routine events, such as unscheduled maintenance. Time periods corresponding to non-routine events may be removed, however, the

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24 Including the PIAM&V Tool developed by OEH to assist in the calculation of energy savings with forward creation for a single site model www.environment.nsw.gov.au/business/piamv-tool.htm

25 Baseline and operating energy models may be based on the same or different variables and constants. Refer to section D.3.3 of this guide for more details.

26 An operating energy model is not required when calculating energy savings and creating ESCs annually.

percentage of time removed must be less than twenty percent of the measurement period.[27]

When establishing energy models, the *measurement boundary* needs to be established (see Figure 3.1). This determines what equipment and parameters will be included and excluded from the energy savings calculations. It effectively sets a boundary for the energy models.

Setting the correct measurement boundary is important as the energy models also need to account for interactive energy savings. These are changes to a site's energy consumption that are due to the implementation, but that occur outside of the measurement boundary.

In a simple example provided in Figure 3.1, a lighting upgrade with more efficient lamps reduces the heat load for a building. This may reduce demand for cooling[28] from the heating, ventilation and air-conditioning (**HVAC**) system and therefore reduce the overall energy consumption for the measurement period, as measured by the utility meter. Any energy savings arising from the changes to HVAC demand need to be estimated and taken into account when determining the normal year energy savings (see Figure 3.2).

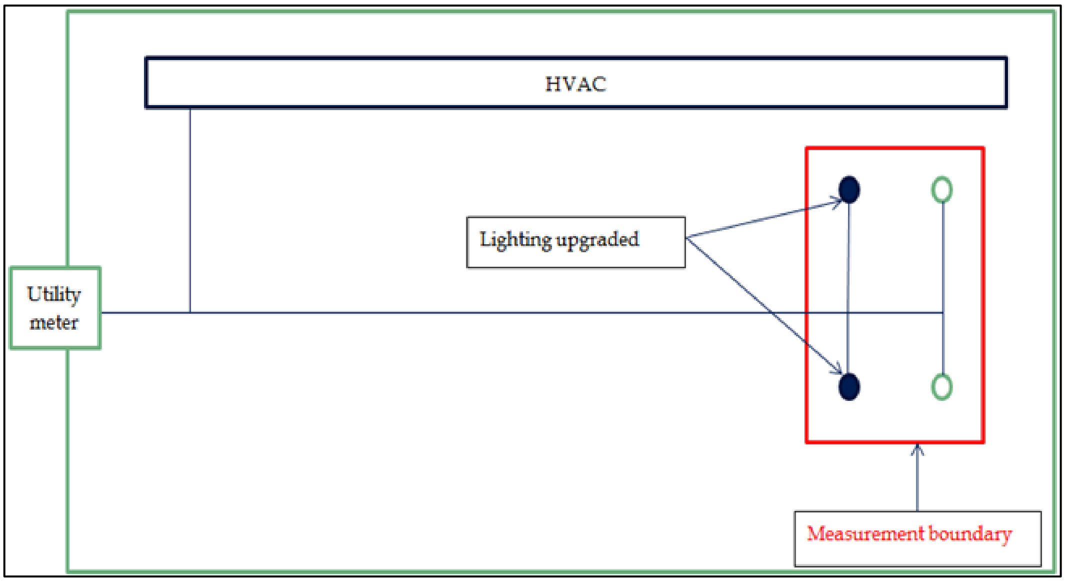
Box 3.4 Evidence of the RESA boundary

Documents must be collected to demonstrate that you have adequate metering in place to define the RESA boundary. This can be evidenced by an electrical line diagram or piping and instrumentation diagram (P&ID) showing the location of the meter(s) used in measuring the energy consumption.

27 *ESS Rule*, cl 7A.5(g)

28 There may be a corresponding increase in heating requirements during colder periods.

Figure 3.1 Example of the measurement boundary showing equipment outside the measurement boundary that may result in interactive energy savings



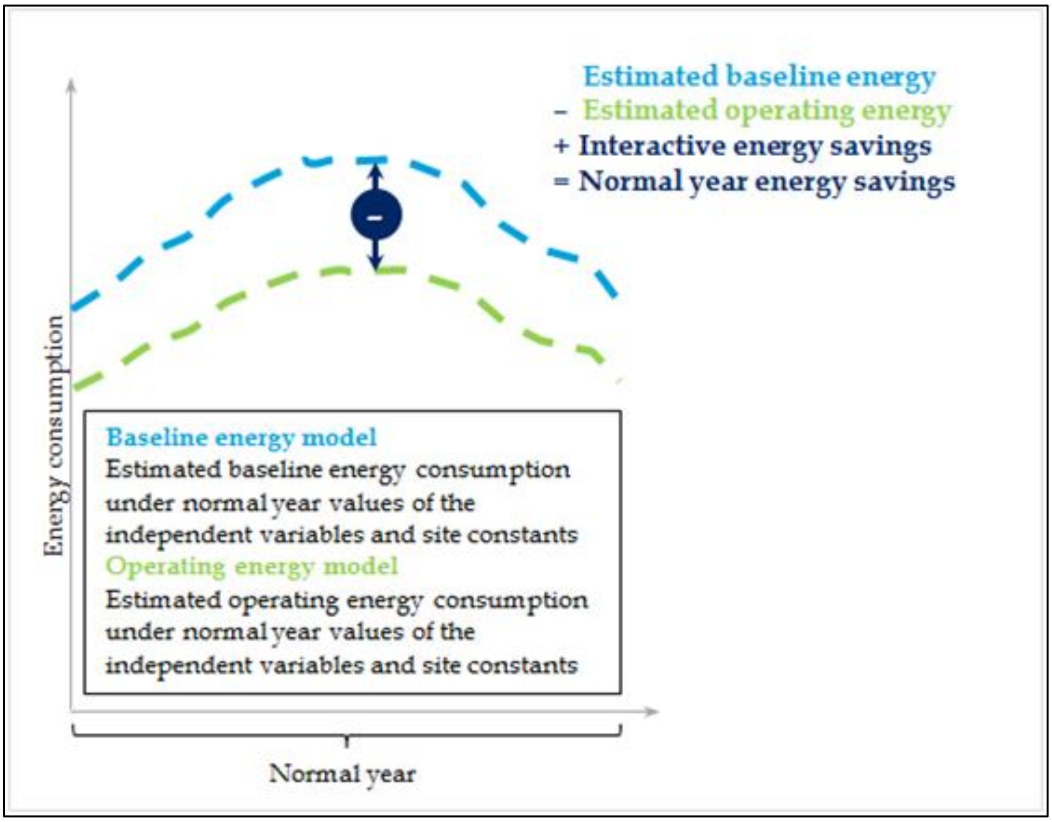
To establish a working energy model, the time period over which measurements are taken must also be established, including the start date and end date of the measurement periods. The values for *energy consumption*, *independent variables* and *site constants* must be within these measurement periods.

The energy savings from an implementation are calculated for savings over a *normal year* (normal year energy savings), as shown in Figure 3.2 below. This figure shows the difference in energy consumption of the baseline and operating energy models for a normal year. A normal year is defined as a typical year of operation of the end-user equipment at a site, after the implementation date.[29]

The *interactive energy savings* must be estimated and added when determining the normal year energy savings. While the interactive savings are not shown on the below figure, the formula in the diagram explains how they are accounted for to determine energy savings.

[29] Clause 7A.12 of the ESS Rule defines the maximum time period for forward creation.

Figure 3.2 Baseline energy model and operating energy model with normal year input conditions (plus any interactive energy savings) defines the normal year energy savings



The calculation of energy savings also requires the use of a *decay factor*, which accounts for the degradation in equipment operation over time.[30]

The decay factor and the interactive energy savings may be influenced by the measurement boundary, the type of end-user equipment that is the subject of the implementation, as well as the site conditions where the implementation occurs. These additional parameters are also explained in further detail in Appendices A and D of this guide.

3.8 Recycling requirements

ACPs are responsible for ensuring that lighting equipment removed or replaced during an implementation is disposed of appropriately. If the post-code of the implementation is in a Metropolitan Levy Area with a postcode listed in Table A25 of the ESS Rule, any lighting equipment containing mercury must be

30 The decay factor may be applied using a default value from Table A16 of the ESS Rule, or estimated from a persistence model in accordance with clause 7A.13 of the ESS Rule.

recycled in accordance with the recycling requirements of a product stewardship scheme such as Fluorocycle or equivalent.[31]

Similarly, any refrigerants that are removed or replaced during a refrigeration equipment upgrade must be disposed of in a manner that is compliant with the *Ozone Protection and Synthetic Greenhouse Gas Management Act 1989*.[32]

3.9 Requirement to use a Measurement & Verification Professional

The ESS Rule requires that an M&V Professional deems as appropriate, the following aspects of the M&V approach for each implementation:

- the parameters used when measuring energy consumption, independent variables, site constants and any other relevant parameters
- the method for selecting independent variables and site constants
- the measurement procedures
- the normal year (not required for annual creation or top-up)
- the effective range
- the interactive energy savings
- the accuracy factor
- use of a persistence model
- the baseline energy model, and
- the operating energy model (except for annual creation or top-up).

The ESS Rule requires the M&V Professional to provide written explanatory reasoning for each of the above.

What is an M&V Professional

An M&V Professional is a person who meets the requirements of clause 7A.15 of the ESS Rule, including that they must be approved by the Scheme Administrator.

The Guide for M&V Professionals outlines these requirements and how interested parties can apply to be approved as an M&V Professional.[33]

31 *ESS Rule*, cl 5.3A(b)(i)
32 *ESS Rule*, cl 5.3A(b)(ii)
33 Refer: www.ess.nsw.gov.au/Methods_for_calculating_energy_savings/Project_Impact_Assessment_with_MV

How to find an M&V Professional

A list of approved M&V Professionals is available from the ESS website.[34]

A person may not meet all of the M&V Professional requirements for all types of energy saving activities. For such cases, this is noted on the M&V Professional list. In choosing an M&V Professional to assess your M&V approach, you will need to ensure that they:

- have relevant skills and experience relating to the particular energy saving activity, and
- are able to conduct an independent assessment of your M&V approach. This means that you will need to use an M&V Professional that has not been involved in developing or implementing the project (including the development of the energy models).

When to use an M&V Professional

You should consider whether to engage an M&V Professional in the design process for each implementation. This will allow the M&V Professional to assess relevant aspects of the M&V approach prior to the commencement of measurement and modelling. Involving an M&V Professional at this stage may reduce the risk of the M&V approach for the implementation not meeting the requirements of the ESS Rule, and also may reduce the risk of invalid ESC creation.

4 Calculating energy savings

The energy savings that can be claimed using this method are limited to:

- a maximum period of 10 years after the implementation date, and
- when using forward creation, a maximum of 50,000 ESCs, for each implementation.

Energy savings can be calculated, and ESCs created, using the following equations from clause 7A of the ESS Rule:

- forward creation for a single site model using equations 7A.1 and 7A.2
- top-up of energy savings using equations 7A.3 and 7A.4, and
- creation based on measured annual energy savings using equations 7A.3 and 7A.4.

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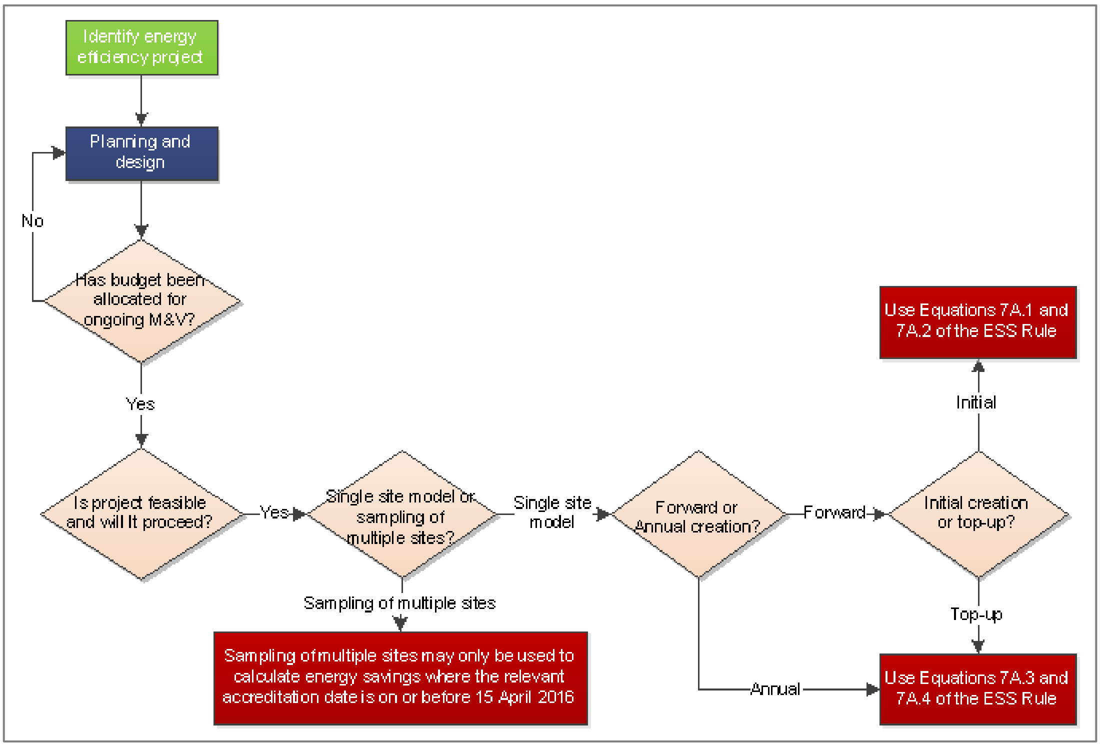
34 Refer: www.ess.nsw.gov.au/Methods_for_calculating_energy_savings/Project_Impact_Assessment_with_MV/List_of_approved_Measurement_Verification_Professionals

If gas and electricity savings are being calculated, they must be calculated separately for each implementation. Where fuel switching occurs, the total number of ESCs (after energy savings are converted to ESCs) must be a positive number (in order to register ESCs).[35]

The equation to calculate electricity savings includes a regional network factor. The applicable regional network factor is based on the post code of the implementation and can be found in Table A24 of the ESS Rule.

See Figure 4.1 below for a flowchart to assist you in determining which equations from the ESS Rule to use for the calculation of energy savings. The three options outlined above are detailed in the following sections.

Figure 4.1 Determining which equation to use for calculating energy savings using the PIAM&V method



4.1 Forward creation of ESCs

Appendix A of this guide describes the steps required to develop the energy models under forward creation.

35 In some gas-to-electricity switching activities, despite total net energy savings being a positive number (ie, the increase in electricity consumption does not offset gas savings), the resulting total ESCs may be a negative value. This is due to the fact that the ESS Rule has a lower ESC conversion factor for gas (0.39) than for electricity (1.06). Refer to Appendix C for more details on fuel switching activities.

Energy savings are calculated using equations 7A.1 and 7A.2 from the ESS Rule. Equation 7A.2 is used to calculate the normal year energy savings, which is then used as an input into equation 7A.1 to calculate the overall energy savings from an implementation.

The process for forward creation of ESCs is outlined in Figure 4.2 below.

Once the normal year energy savings are determined, the 'lifetime' energy savings need to be calculated, for example, over 10 years. The lifetime energy savings are based on the expected life of the end-user equipment (to a maximum of 10 years) and the following additional factors:

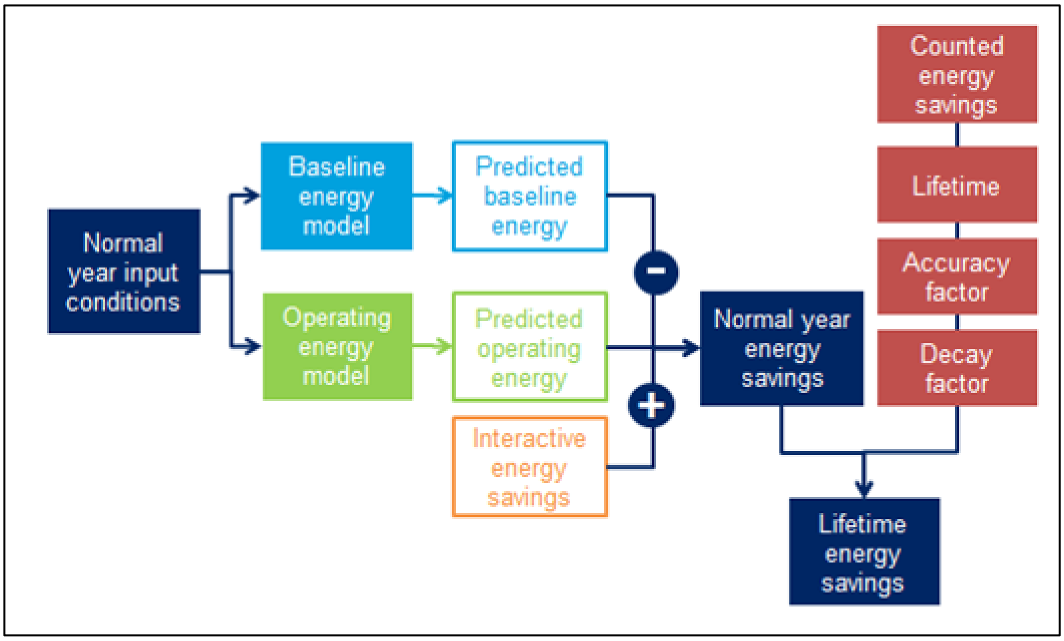
- an *accuracy factor*, with a value between 0 and 1, is used to discount the energy savings according to the relative precision of the calculation of the energy savings[36]
- a *decay factor*, either from a persistence model[37] or from default values, is used to discount the normal year energy savings to calculate the lifetime energy savings, and
- any *counted energy savings* from previous ESC creation for the RESA or at the same site from another RESA (or corresponding scheme),[38] which must also be deducted.

36 This is estimated from the predicted energy consumption derived from an energy model.

37 A persistence model is essentially a model that forecasts the continuation of energy savings from a RESA (ie installed energy-efficient equipment) over its useful lifetime. When a persistence model is used to calculate the decay factor, the persistence model must also estimate the expected lifetime of the end-user equipment (refer clause 7A.13(b)(i) of the ESS Rule).

38 Clause 53(2) of the Regulation gives the Scheme Administrator the power to require the surrender of ESCs for which a benefit was obtained under a corresponding scheme, such as the Commonwealth Government's Emission Reduction Fund (ERF).

Figure 4.2 Process for determining lifetime energy savings for forward creation



4.2 Top-up after forward creation of ESCs

Top-up refers to creating ESCs from the difference between the predicted (deemed) baseline energy consumption and the actual measured operating energy consumption for a year. Top-up is allowed where energy savings can be demonstrated beyond those calculated for the lifetime energy savings, discounted by an accuracy factor and reduced by any counted energy savings, as shown in Figure 4.3 below. This option is only available where ESCs have already been created for the site through forward creation.

Appendix A of this guide describes the steps required to top-up energy savings after you have forward created.

The site, activity and boundary must be the same as already defined in step 1 for the forward creation approach, which is described in Table A.1 of this guide.

You must check if there have been any changes to end-user equipment within the defined measurement boundary following the implementation of the RESA. If changes have occurred, for example the addition of new end-user equipment as part of a brownfield expansion,[39] a non-routine adjustment may be required to adjust the energy consumption for the effect of the change in end-user equipment.

[39] A brownfield expansion refers to the expansion of a facility at a site, as opposed to a new build on a site with no previous facility, which is referred to as a greenfield site.

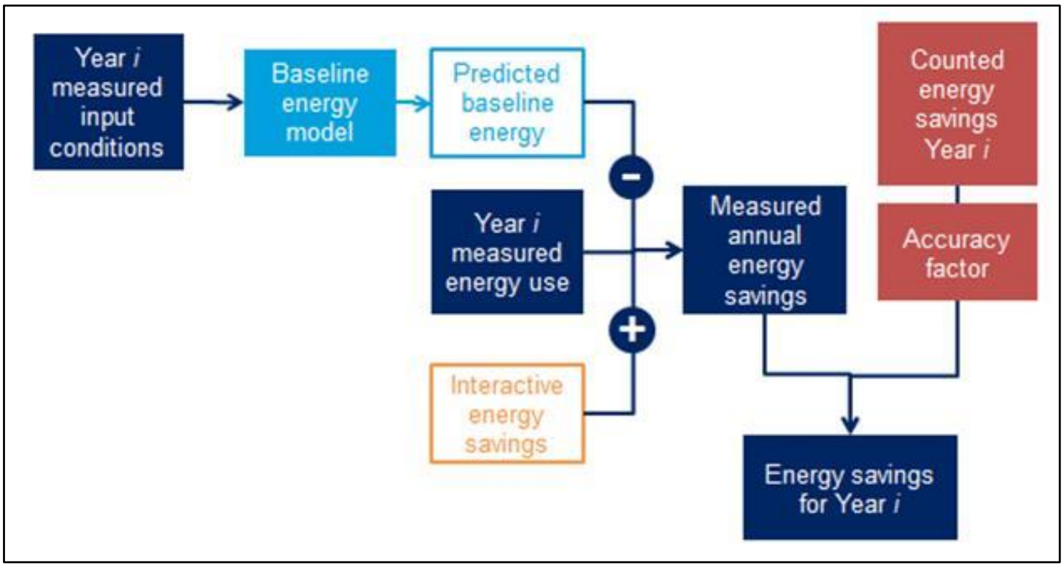
Energy savings are calculated using equations 7A.3 and 7A.4 from the ESS Rule. Equation 7A.4 is used to calculate the measured annual energy savings, which is then used as an input into equation 7A.3 to calculate the uncredited energy savings from the implementation.

The calculation of top-up energy savings includes:

- actual values used as inputs to the baseline operating model, including the actual non-routine adjustments and interactive energy savings
- updating the accuracy factor, which may increase if the relative precision of energy savings increases, and
- determining energy savings from any previous ESC creation for the RESA, either under forward creation or from other RESAs at the same site.

The baseline energy model must be based on a measurement period that has an end date no more than ten years prior to the end date of the measurement period for which energy savings are being claimed.

Figure 4.3 Process for top-up of ESCs



4.3 Annual creation of ESCs

Table A.3 of this guide describes the steps required to develop the energy models under annual creation.

In order to create ESCs using this approach, you must first check if there have been any changes to end-user equipment within the defined measurement boundary following the implementation of the RESA. If changes have occurred, for example the addition of new end-user equipment as part of a brownfield expansion, a non-routine adjustment is required to adjust the energy consumption for the effect of the change in end-user equipment.

Energy savings are calculated using equations 7A.3 and 7A.4 from the ESS Rule. Equation 7A.3 is used to calculate the energy savings from the implementation. Equation 7A.4 is used to calculate the measured annual energy savings.

ESCs can be calculated annually for an implementation, by measuring the actual operating energy consumption for a full year after an implementation, against energy consumption that is estimated using a baseline energy model. Unlike forward creation, no operating energy model is used. The calculation of energy savings are based on:

- an accuracy factor, with a value between 0 and 1, which is used to discount the energy savings according to the relative precision of the calculation of the energy savings determined, and
- any counted energy savings from previous ESC creation for the RESA or at the same site from another RESA, (or corresponding scheme), which must also be deducted.

The equations used are the same as for calculating energy savings from top-up (see section 4.2 of this guide).

The baseline energy model must be based on a measurement period that has an end date no more than ten years prior to the end date of the measurement period for which energy savings are being claimed.

5 Calculating and creating ESCs

Once energy savings have been calculated for an implementation, Equation 1 of the ESS Rule can be used to calculate the number of ESCs that may be created. Note that ESCs can only be created where Equation 1 has a result that is greater than zero.

Equation 1

Number of Certificates = $\Sigma_{Implementations}$ *Electricity Savings x Electricity Certificate Conversion Factor + Gas Savings x Gas Certificate Conversion Factor*

5.1 Creation of ESCs based on a multiple-site model

This approach can be used to calculate energy savings for implementations across multiple sites using sampling, one baseline energy model and one operating energy model. Clause 7A.1(c) of the ESS Rule establishes that ACPs can only use this approach if they were accredited on or before 15 April 2016.

5.2 Applying to register ESCs

Certain information must be submitted to the Scheme Administrator **before an ACP applies to register** ESCs created from energy savings arising from an implementation or implementations.[40] ACPs are to provide the required information by completing an Implementation Data Sheet[41] and submitting it through the ESS Portal.[42]

The Implementation Data Sheet will include a calculation of the number of ESCs to be created in accordance with Equation 1 in the ESS Rule. This calculation involves:

- multiplying the electricity savings from the implementation or implementations by the electricity certificate conversion factor (1.06)[43]
- multiplying the gas savings from the implementation or implementations by the gas certificate conversion factor (0.39),[44] and
- adding the two figures together. If this number is a fraction it is rounded down to the nearest whole number.

The result is the total number of ESCs that ACPs can apply to the Scheme Administrator to register from the implementation or implementations. If the result is not a whole number, it is rounded down to the nearest whole number.

There are no restrictions on how many implementations can be bundled together in the same Implementation Data Sheet. However:

- ACPs must apply to register all ESCs included in an Implementation Data Sheet in a single application
- ACPs cannot split energy savings calculated from a single implementation across two or more Implementation Data Sheets, and
- each Implementation Data Sheet must only include the calculation of energy savings that are taken to have occurred in the same calendar year (commonly referred to as 'vintage').

When determining how many Implementations to bundle in the same Implementation Data Sheet, ACPs should consider:

40 *ESS Rule,* cl 6.8
41 Available at www.ess.nsw.gov.au/Registry/Registering_certificates
42 Information and access to the portal can be found here: www.ess.nsw.gov.au/ESS_Portal
43 Specified in section 130(1) of the Act
44 Specified in section 130(1) of the Act

- the ESC creation limit specified in their Accreditation Notice, as they must be able to register all the ESCs in the bundle at the same time, and
- the cost of registering the ESCs.[45]

More information on applying to register the creation of ESCs can be found on the ESS website.

The maximum number of ESCs that you can bring forward for any one implementation is 50,000 (or 50,000 notional MWh of energy savings).[46]

6 Applying for accreditation

A completed application for this method is required for a person or organisation to become an Accredited Certificate Provider and create ESCs. An application has multiple parts, which are explained in the Application Guide.[47]

6.1 Application options

Developing an application to use the PIAM&V method can be costly and time-consuming. As such, three application options are provided for applicants.

- *Option 1* is the minimum information that can be provided to be considered for accreditation and will focus on the eligibility of the applicant for accreditation and general record keeping processes.
- *Option 2* can be used to demonstrate a more thorough understanding of the method, by the provision of a proposed M&V Plan and baseline energy model and all supporting information.
- *Option 3* requires a fully worked example, demonstrating the application of baseline and operating energy models in an M&V report, calculations for ESC creation for an implementation, and a completed M&V Professional report. If the activity is implemented prior to accreditation, it can only be used for demonstration purposes.[48]

For example, if you wish to implement a RESA at multiple sites, you can apply to become accredited using information from an implementation that has already occurred – to demonstrate your ability to calculate energy savings in accordance

45 The ESC registration fee must be paid in a single payment for all ESCs registered in a single bundle. Payment for a single bundle cannot be split into two payments. Refer: www.ess.nsw.gov.au/Registry/Registering_certificates
46 As required by clause 7A.11(c) of the ESS Rule.
47 Refer: www.ess.nsw.gov.au/How_to_apply_for_accreditation/Apply_now_-_guides_and_application_forms
48 To meet the requirements of clause 6.2(a) of the ESS Rule.

with the requirements of the PIAM&V method. ESCs would not be able to be created for this implementation, as ESCs can only be created for implementations with an implementation date that is after the date of accreditation.

Depending on which application pathway is used, the Scheme Administrator may apply different types of conditions to the accreditation, such as:

- Option 1 accreditation may result in a zero ESC creation limit (ie, no ESCs allowed to be created); a spot audit regime (ie, an audit at any time); and a requirement that the ACP submit certain information to the Scheme Administrator.
- Option 2 accreditation may result in a pre-registration audit regime, with audits conducted by an auditor approved to conduct PIAM&V audits.
- Option 3 accreditation may result in the standard conditions as applied to ACPs by reference to the Compliance and Performance Monitoring Strategy.[49]

ACPs accredited under either Option 1 or Option 2 will have certain conditions placed on their accreditation that may limit their ability to create ESCs until they provide further information to the Scheme Administrator, or successfully complete an audit. Once these conditions are met, ACPs can then submit an application for amendment of their conditions to the Scheme Administrator.[50]

6.2 Scope of RESA

Those wanting to implement multiple activities that cover different technologies or industries, should group the activities by industry or technology type. The scope of each accreditation needs to be specific enough so that the methodology can be applied to all implementations under the accreditation.

For example, the energy models developed to account for compressed air energy savings (dependent on production) are likely to be significantly different from energy models dealing with HVAC (dependent on weather). Keeping these different scenarios separate makes it easier to develop discrete M&V plans and energy models. The more complexity that is built-in, by trying to combine different technologies and industry types, the greater the risk of invalid ESCs being found at audit.

49 Refer: www.ess.nsw.gov.au/Audits_and_Compliance/Audit_and_compliance_guides

50 Refer: www.ess.nsw.gov.au/Accredited_Certificate_Providers/Accreditation_Notice_and_Amendments

6.3 Existing Project Impact Assessment Method accreditations

Those accredited to use the Project Impact Assessment Method (**PIAM**)[51] can apply to have the PIAM&V method added to their existing accreditation if they are interested in using the PIAM&V method to calculate additional energy savings for past implementations. They may also want to add the PIAM&V method to an existing PIAM accreditation for future implementations of an activity for which they are already accredited. In both cases, ACPs will need to complete an application for amendment of their conditions of accreditation and include a completed PIAM&V Application Form Part B to demonstrate their ability to calculate energy savings using the PIAM&V method.[52]

Once an application for amendment is received, the Scheme Administrator will consider the information provided and will determine if the PIAM&V method can be added to the existing PIAM accreditation. Depending on the application, additional information may be requested, and audits may be required before ESCs can be registered.

7 Minimum required records

ACPs are required to keep records of the energy saving activity, including:

- the location in which the energy savings activity occurred
- the energy savings arising from that activity
- the methodology, data and assumptions used to calculate those energy savings, and
- any other records specified by the Scheme Administrator.[53]

ACPs must retain records for at least six years, in a form and manner approved by the Scheme Administrator. Each ACP's Accreditation Notice may include a condition requiring that the ACP's record keeping arrangements are consistent with the ESS Record Keeping Guide.[54]

The boxes throughout this document and the tables in the appendices provide some guidance as to the minimum information that should be kept as a record of the energy savings from each implementation. Those applying for accreditation, however, will need to provide detailed information in their application as to the records they intend to keep to support ESC creation.

51 *ESS Rule*, cl 7

52 Refer: www.ess.nsw.gov.au/How_to_apply_for_accreditation/Apply_Now_-_Guides_and_Application_Forms

53 *Electricity Supply (General) Regulation 2014*, cl 46

54 Available at www.ess.nsw.gov.au/Accredited_Certificate_Providers/Record_keeping_arrangements

8 Glossary

Term	Definitions
ACP	Accredited Certificate Provider
Accredited Certificate Provider	A person accredited under the ESS to create ESCs for Recognised Energy Saving Activities.
Accuracy factor	A number between 0 and 1, used to discount energy savings according to the relative precision of normal year energy savings at 90% confidence level.
Coefficient of variation	The sample standard deviation expressed as a percentage of the sample mean.
Computer simulation	A method to establish an energy model that uses software to simulate energy consumption by end-user equipment and can be tested against statistical requirements Published by the Scheme Administrator.
Decay factor	A number between 0 and 1 which quantifies the decay of the energy savings due to equipment degradation over time.
Effective range	The range over which values of independent variables and / or site constants for which a baseline energy model or operating energy model (as the case may be) is valid.
Electricity savings	The reduction of the amount or equivalent amount of electricity consumption (in MWh) arising from the implementation, may be negative for fuel switching activities.
Energy model	A mathematical model describing the energy use profile before an implementation (baseline) and after an implementation (operating) occurs.
Energy saver	Refer to section 3.1 of this guide.
Energy savings	Electricity savings or gas savings or both
ESC	Energy Savings Certificate
ESS	Energy Savings Scheme
ESS Rule	Energy Savings Scheme Rule of 2009
Estimate of the mean	A method in PIAM&V that can be used to establish an energy model.
Gas	Any fuel listed in National *Greenhouse and Energy Reporting (Measurement) Determination 2008* (Cth) Schedule 1 Part 2—Fuel combustion—gaseous fuels or liquefied petroleum gas.
Gas savings	The reduction of the amount of gas combusted for stationary energy (in MWh) arising from the implementation, may be negative for fuel switching activities.

Term	Definitions
Implementation	The delivery of a Recognised Energy Saving Activity at a site.
Implementation date	Refer to section 3.3 of this guide.
Independent variable	A parameter that varies over time, that can be measured and affects the end-user equipment's energy consumption at a site.
Interactive energy savings	A change in a site's energy consumption due to interactions with end-user equipment for which energy consumption is not measured.
Measurement and verification professional	Refer to section 3.9 of this document.
Measurement boundary	The area of a site that is subject to the implementation, where the energy consumption by any end-user equipment located within it is directly affected by the implementation.
Measurement period	The duration of time over which measurement of energy consumption will be taken for the purposes of calculating the energy savings.
Non-routine events	Events which affect energy use, within the chosen measurement period, that are not modelled by any independent variables or site constants. They are required to be removed from the measurement period to enable like-for-like comparison of before and after energy savings scenarios. They are typically due to static factors that may include fixed, environmental, operational and maintenance characteristics.
Normal operations	Typical operating conditions of end-user equipment, excluding commissioning.
Normal year	A typical year for the operation of the end-user equipment at the site after the implementation date.
Number of model parameters	In relation to an energy model, means the number of parameters required to unambiguously define the functional form of the energy model. In a linear energy model, it is the number of coefficients or the number of independent variables and site constants that are used to explain energy consumption variation.
Persistence model	A model used to forecast the continuation of energy savings from an implementation over its useful lifetime.
Pre-implementation period	The measurement period prior to the implementation period.
Purchaser	Refer to section 3.2 of this guide.
Regression analysis	A method in PIAM&V used to establish an energy model that determines a mathematical function for approximating the relationship between energy consumption and independent variables and / or site constants and includes, but is not limited to, linear regression, and mixed models.

Term	Definitions
Relative precision	A measure of the relative range within which a true value is expected to occur with some specified confidence level.
RESA	Recognised Energy Saving Activity
Sampling method	The statistical method for conducting measurements on a subset of a population to estimate the characteristics of the entire population.
Site constant	A parameter for a site, which does not vary over time under normal operating conditions, and affects the end-user equipment's energy consumption.

Appendices

Contents

A Guidance for calculation of energy savings

This section of the guide provides more detail on applying the ESS Rule to calculate energy savings. The tables step out key requirements of the ESS Rule, but are guidance only, so care must be taken to ensure all ESS Rule requirements are met.

The tables reference the OEH PIAM&V Tool[55] that steps through the requirements of the ESS Rule for forward creation with a single site model utilising regression analysis. Use of the tool is recommended, but is not required.

The M&V Plan (or other supporting documents) developed for each implementation is expected to address each section of the tables below relevant to the energy model being developed. More information on developing M&V Plans can be found in Appendices D and E of this document.

A.1 Forward creation at an individual site

Table A.1 provides a step-by-step approach to developing energy models for use with forward creation at a single site; to meet the requirements of clause 7A.1(a) of the ESS Rule. Each of the steps in Table A.1 matches the sections of the OEH PIAM&V Tool.

A.2 Top-up after forward creation at an individual site

Table A.2 provides a step-by-step approach to top-up after forward creation at a single site; to meet the requirements of clause 7A.1(b) of the ESS Rule. The calculation of ESCs using this approach is not included in the OEH PIAM&V Tool.

A.3 Annual creation at an individual site

Table A.3 provides a step-by-step approach to annual creation at a single site; to meet the requirements of clause 7A.1(b) of the ESS Rule. The calculation of ESCs using this approach is not included in the OEH PIAM&V Tool.

[55] Refer: www.environment.nsw.gov.au/business/piamv-tool.htm%20

Table A.1 Detailed calculation steps when using forward creation at an individual site

Step	Description and PIAM&V Tool reference	Details
1	Define implementation, site and measurement boundary ▼ Step 1 in the *Boundaries and variables* sheet	▼ Describe the equipment or process that will comprise the RESA, including: – performance characteristics of the end-user equipment, including that used to modify the system, and – consideration of Australian certification, performance and safety standards applicable to the equipment. ▼ The measurement boundary must include all end-user equipment whose energy consumption will be effected by the RESA, where feasible: – consider setting the measurement boundary to minimise the proportion of measured energy consumption that is unrelated to the project. ▼ Define the measurement boundary with reference to: – the business / operating cycle – independent variables impacting energy use within the boundary, and – site constants impacting energy use at the boundary.

Step	Description and PIAM&V Tool reference	Details
2	Define energy model data frequency and variables ▾ Steps 2a and 2b in the *Boundaries and variables* sheet	▾ For each energy model, define the data frequency for measurements of: – energy consumption – independent variables – site constants, and – any other relevant parameters. ▾ The frequency of these measurements must be consistent to allow them to be used in the energy models. ▾ For each variable, site constant and energy consumption, include: – name, description and units – measurement procedure, including responsibility for recording and reporting measurement equipment – how any measurements were converted to a different frequency for use in the energy model – any calculations performed on measurements to derive each input – the value of a site constant or independent variable during normal operating conditions, and – measurement accuracy (relative error or absolute error). ▾ To further support the energy model development process, identify and define variables that are neither independent variables nor site constants (i.e. will not be used in an energy model), including details of: – assigned name, description and units – measurement procedure – typical value or range of values, and – reason they have been excluded from the model. ▾ This may include any number of variables that were considered as inputs to the energy model, but were not included in the final energy model, for example due to finding that the variable had very little influence in describing variations in energy use.

Step	Description and PIAM&V Tool reference	Details
3	Establish normal year of operating conditions ▾ Step 3a on the *Data - Normal year* sheet to enter normal year values for each independent variable and site constant ▾ Step 3b on the *Normal year* sheet for all other information	▾ Define values for independent variables and site constants over a normal year of operation, representing a typical year of operation for the end-user equipment over the maximum time period for forward creation. ▾ When defining a normal year, ACPs must: – consider future 'typical' operating conditions of the site, which may differ from the baseline period. Operating conditions may include typical weather conditions, operating days per year, maintenance periods, changes in site activities (ie production levels), etc, – use actual data rather than estimates, where practical (typically, data should not be older than 3 years to be indicative of current/predicted performance), – describe how the normal year is constructed, noting any adjustments, calculations or manipulations, and – where the operating cycle of the system is less than one year, the normal year may be constructed by combining values from multiple operating cycles to make up one year.
4	Establish baseline energy model ▾ Step 4a on the *Data - baseline* sheet to enter normal year values for each independent variable and site constant ▾ Step 4b on the *Baseline Energy Model* sheet to define the model	▾ Establish the baseline energy model to estimate the energy consumption in the absence of the implementation, as a function of independent variables and site constants measured under normal operating conditions and based on a normal year. ▾ The baseline energy model may be established by: – estimate of the mean that is based on measurements of energy consumption, independent variables and site constants, where relevant, specifies a measurement period, and where the coefficient of variation of the energy consumption over the measurement period is less than 15% – regression analysis that is based on measurements of energy consumption, independent variables and site constants, specifies a measurement period, and where the number of independent observations for the independent variables when calculated in accordance with clause 7A.6 of the ESS Rule is at least six times the number of model parameters in the energy model, or – computer simulation using a commercially available software package determined to be acceptable by the Scheme Administrator (refer section B.2 of this guide). ▾ For new-end user equipment, the baseline energy model may be established by one of the above methods, by using average energy performance of the same type of end-user equipment, to transform the measurements of energy consumption, independent variables and site constants into inputs, used to establish the operating energy model.

Step	Description and PIAM&V Tool reference	Details
5	Implement and commission activity ▾ Step 5 on the *Implementation* sheet	▾ Define and record the implementation date. ▾ Determine the length of the measurement period for the operating energy model, with a start date occurring after the implementation date.
6	Establish operating energy model ▾ Step 6a on the *Data-operating* sheet ▾ Step 6b on the *Operating model* sheet	▾ Establish operating energy model to estimate the energy consumption following implementation, as a function of independent variables and site constants measured under normal operating conditions and based on a normal year. ▾ The operating energy model may be established by: – estimate of the mean that is based on measurements of energy consumption, independent variables and site constants, where relevant, specifies a measurement period, and where the coefficient of variation of the energy consumption over the measurement period is less than 15% – regression analysis that is based on measurements of energy consumption, independent variables and site constants, specifies a measurement period, and where the number of independent observations for the independent variables when calculated in accordance with clause 7A.6 of the ESS Rule is at least six times the number of model parameters in the energy model (refer section B.1 of this guide), or – computer simulation using a commercially available software package determined to be acceptable by the Scheme Administrator (refer section B.2 of this guide).
7	Calculate interactive energy savings ▾ Step 7 on the *Interactive Energy Savings* sheet	▾ Identify and define interactive effects, which lead to interactive energy savings, by including all end-user equipment outside of the measurement boundary that will have its energy consumption affected by the RESA. ▾ Include written explanation as to why the measurement boundary has not been modified to include this equipment. ▾ An example of an interactive effect is a decrease in the energy requirements for a cooling system, located outside of the measurement boundary, which occurs as a result of a project that installs high efficiency lights that emit less heat. ▾ When estimating interactive energy savings, they cannot represent more than 10% of total energy savings respectively, unless they are estimated in accordance with a guidance document published by the Scheme Administrator.

Step	Description and PIAM&V Tool reference	Details
8	Calculate normal year energy savings ▼ Step 8 on the *Normal Year Energy Savings* sheet, based on previously entered values	▼ Calculate normal year energy savings, in MWh, using Equation 7A.2 by substituting the value of independent variables from the normal year into the baseline energy model and operating energy model, and using the interactive energy savings calculated in step 7. ▼ Any time periods for which any of the normal year values for the independent variables are less than 95% of the minimum or greater than 105% of the maximum of the effective range for either the baseline energy model or operating energy model must be excluded from the energy savings calculation. ▼ Additionally, any time periods where the site constants are not their standard value must be excluded from the savings calculation.
9	Apply accuracy factor ▼ Step 9 on the *Accuracy Factor* sheet, based on previously entered values	▼ You must apply an accuracy factor (as specified in Table A23 of the ESS Rule or as otherwise determined by another process published by the Scheme Administrator) that corresponds to the relative precision[a] of the energy savings estimate at a 90% confidence level. ▼ The relative precision of the energy savings estimate must take into account model uncertainty, input and output measurement uncertainty[b], and where relevant, sampling uncertainty. ▼ Depending on the measurement frequency, the relative precision may also need to be adjusted for autocorrelation effects.

Step	Description and PIAM&V Tool reference	Details
10	Determine lifetime and decay factors ▾ Step 10 on the *Decay Factor* sheet, to either use decay factors or the built-in persistence model	▾ The expected lifetime of the end-user equipment determines the maximum time period for forward creation, to a maximum of ten years after the implementation date (or five years for RESAs previously created under PIAM). ▾ In addition, a decay factor is used to estimate the decay of the energy savings due to equipment degradation over its lifetime. **Decay factors** ▾ A decay factor can be estimated by either using a persistence model or specified default values from Table A16 of the ESS Rule. **Persistence model** ▾ If a persistence model is being applied, it must take into account: – the business classification of the site (from Table A18 of the ESS Rule), if known and relevant – the end-user equipment type, – the operating hours (as determined by measurements) for the end-user equipment, and – typical ambient conditions for that site, including temperature, humidity and salinity. ▾ It also needs to: – estimate the expected lifetime of the end-user equipment in whole years – estimate the decay factor for each future year within the maximum time period for forward creation, and – be publicly accessible and accepted for use by the Scheme Administrator. ▾ If using the built-in persistence model with the PIAM&V Tool, some inputs are fixed. To use other inputs, you will need to submit evidence that is acceptable to the Scheme Administrator.
11	Determine counted energy savings Step 11 of the *Counted Energy Savings* sheet	▾ It is possible that energy savings may have already been claimed in relation to the end-user equipment within the measurement boundary, in which case they must be identified and accounted for. ▾ As this calculation is for the initial forward creation of certificates, ESCs must not have previously been created for the implementation under this RESA (or a corresponding scheme). ▾ For counted energy savings that are from energy savings under a different RESA, determine the counted energy savings for the implementation in each year.

Step	Description and PIAM&V Tool reference	Details
12	Calculate energy savings Step 12 on the *Energy Savings Summary* sheet	▼ The energy savings to be forward created over the maximum time period for forward creation are then calculated according to Equation 7A.1.

a The equation for calculating relative precision at 90% confidence level is (t-statistic x sample standard error)/estimate, where the estimate is any empirically derived value of a parameter of interest (p. 91 – IPMVP vol.1 2012).

b Input measurement uncertainty arises from independent variables (eg, weather conditions), while output measurement uncertainty is estimated from the accuracy of an instrument used to measure energy use.

Table A.2 Detailed calculation steps for topping-up after forward creation at an individual site

Step	Description	Details
1	Measure operating energy consumption	▼ Measure the operating period energy consumption, along with all independent variables and site constants that were defined for the RESA for the forward creation sub-method. ▼ Measurement period must be for a full year that commences on the anniversary of the implementation date as previously determined for the RESA for the forward creation sub-method, and must end within the maximum time period for forward creation.
2	Calculate interactive energy savings	▼ Calculate the interactive energy savings as defined for the RESA for the forward creation sub-method as per step 7 of Table A.1 of this guide. ▼ The interactive energy savings must be adjusted to be representative of operating period conditions.
3	Calculate measured annual energy savings	▼ Calculate measured annual energy savings, in MWh, using Equation 7A.4 of the ESS Rule. – The predicted baseline energy consumption is determined by substituting values of independent variables from a measurement period into the baseline energy model. – The operating energy consumption is as measured during a measurement period. – The interactive energy savings are calculated as per step 2. ▼ Exclude any time periods for which any values for the independent variables fall outside the effective range of the baseline energy model, for the purpose of calculating energy savings. ▼ Additionally, any time periods where the site constants are not their standard value must be excluded from the savings calculation.
4	Apply accuracy factor	▼ The accuracy factor is either the value in Table A23 of the ESS Rule that corresponds to the relative precision of the energy savings estimate at a 90% confidence level, or the value determined by another process published by the Scheme Administrator. ▼ The energy savings estimate is the measured annual energy savings as defined in Equation 7A.3 of the ESS Rule. ▼ The relative precision of the energy savings estimate must account for model and measurement uncertainty.[a] ▼ For the measured operating period energy consumption, only output measurement uncertainty is considered. ▼ Depending on the measurement frequency, the relative precision may also need to be adjusted for autocorrelation effects.

Step	Description	Details
5	Determine counted energy savings	▼ It is possible that energy savings may have already been claimed in relation to the end-user equipment within the measurement boundary, in which case they must be identified and accounted for. ▼ Account for energy savings for the RESA determined using the forward creation sub-method for each measurement period. ▼ Counted energy savings that are from energy savings under a different RESA (or a corresponding scheme), not included in the counted energy savings during the forward creation sub-method, must also be included for each measurement period.
6	Calculate energy savings	▼ The energy savings for a measurement period are then calculated according to Equation 7A.3 of the ESS Rule.

a Input measurement uncertainty arises from independent variables (eg, weather conditions), while output measurement uncertainty is estimated from the accuracy of an instrument used to measure energy use.

Table A.3 Calculation steps for annual creation at an individual site

Step	Description	Details
1	Define implementation, site and measurement boundary	Describe the equipment or process that will comprise the RESA, including: ▾ performance characteristics of the end-user equipment, including that used to modify the system, and ▾ consideration of Australian certification, performance and safety standards applicable to the equipment. The measurement boundary must include all end-user equipment whose energy consumption will be affected by the RESA, where feasible: ▾ consider setting the measurement boundary to minimise the proportion of measured energy consumption that is unrelated to the project. Define the measurement boundary with reference to: ▾ the business / operating cycle ▾ independent variables impacting energy use within the boundary, and ▾ site constants impacting energy use at the boundary.
2	Define energy model data frequency and variables	For the baseline energy model, define the data frequency for measurements of: ▾ energy consumption ▾ independent variables, and ▾ site constants. The frequency of these measurements must be consistent to allow them to be used in the baseline energy model. For each variable, site constant and energy consumption, include: ▾ name, description and units ▾ measurement procedure, including responsibility for recording and reporting measurement equipment ▾ how any measurements were converted to a different frequency for use in the baseline energy model ▾ any calculations performed on measurements to derive each input, and ▾ the value of a site constant or independent variable during normal operating conditions, and ▾ measurement accuracy (relative error or absolute error). To further support the baseline energy model development process, identify and define variables that are neither independent variables nor site constants (i.e. will not be used in the baseline energy model), including details of: ▾ assigned name, description and units, and ▾ measurement procedure.

Step	Description	Details
		This may include any number of variables that were considered as inputs to the energy model, but were not included in the final energy model, for example due to finding that the variable had very little influence in describing variations in energy use.
3	Establish baseline energy model	Establish the baseline energy model to estimate the energy consumption in the absence of the implementation, as a function of independent variables and site constants. The baseline energy model may be established by: ▾ an estimate of the mean that is based on measurements of energy consumption, Independent Variables and Site Constants, where relevant, specifies a Measurement Period, and where the Coefficient of Variation of the energy consumption over the Measurement Period is less than 15%, or ▾ regression analysis that is based on measurements of energy consumption, Independent Variables and Site Constants, specifies a measurement period, and where the number of independent observations for the independent variables when calculated in accordance with clause 7A.6 of the ESS Rule is at least ten times the degrees of freedom in the energy model (refer Table A.3 of this guide), or ▾ computer simulation using a commercially available software package determined to be acceptable by the Scheme Administrator. For new-end user equipment, the baseline energy model may be established by one of the above methods, by using average energy performance of the same type of end-user equipment, to transform the measurements of energy consumption, independent variables and site constants into inputs, used to measure the annual energy savings.
4	Implement and commission activity	Define and record the implementation date.
5	Measure operating energy consumption	Measure the operating period energy consumption, along with all independent variables and site constants that were defined for the RESA. ▾ The measurement period must be for a full year, and commences after the implementation date.
6	Calculate interactive energy savings	Identify and define interactive effects, which lead to interactive energy savings, by including all end-user equipment outside of the measurement boundary that will have its energy consumption affected by the RESA. ▾ Include written explanation as to why the measurement boundary has not been modified to include this equipment. ▾ An example of an interactive effect is a decrease in the energy requirements for a cooling system, located outside of the measurement boundary, which occurs as a result of a project that installs high efficiency lights that emit less heat. ▾ When estimating interactive energy savings, they cannot represent more than 10% of total energy savings respectively, unless they are estimated in accordance with a guidance document published by the Scheme Administrator.

Step	Description	Details
7	Calculate measured annual energy savings	Calculate measured annual energy savings, in MWh, using Equation 7A.4 of the ESS Rule. ▼ The predicted baseline energy consumption is determined by substituting values of independent variables from a measurement period into the baseline energy model. ▼ The operating energy consumption is as measured during a measurement period. ▼ The interactive energy savings are calculated as per step 6. ▼ Exclude any time periods for which any values for the independent variables fall outside the effective range of the baseline energy model, for the purpose of calculating energy savings. ▼ Additionally, any time periods where the site constants are not their standard value must be excluded from the savings calculation.
8	Apply accuracy factor	The accuracy factor is the value in Table A23 of the ESS Rule, or as otherwise determined by another process published by the Scheme Administrator, that corresponds to the relative precision of the energy savings estimate at a 90% confidence level. ▼ The energy savings estimate is the measured annual energy savings as defined in Equation 7A.3 of the ESS Rule. ▼ The relative precision of the energy savings estimate must account for model and measurement uncertainty. ▼ For the measured operating period energy consumption, only output measurement uncertainty is considered. ▼ Depending on the measurement frequency, the relative precision may also need to be adjusted for autocorrelation effects.
9	Determine counted energy savings	It is possible that energy savings may have already been claimed in relation to the end-user equipment within the measurement boundary, in which case they must be identified and accounted for. ▼ Energy savings for the RESA determined using the forward creation sub-method for each measurement period. ▼ Counted energy savings that are from energy savings under a different RESA (or corresponding scheme), not included in the counted energy savings during the forward creation sub-method, must also be included for each measurement period.
10	Calculate energy savings	The energy savings for a measurement period are then calculated according to Equation 7A.3 of the ESS Rule.

B Guidance for development of energy models

B.1 Establishing energy models by regression analysis

ACPs can use regression analysis to establish an energy model to estimate the energy consumption of a system subject to a number of independent variables and site constants that vary over time.

The energy model will be established for:

- baseline conditions, before implementation (forward creation and top-up sub-methods), and
- operating conditions, after implementation (for forward creation sub-method).

The energy model expresses the energy consumption as a mathematical function of the independent variables and is used to perform "routine adjustments", as defined under the IPMVP.

The form of the model is defined based on the independent variables and site constants, and a regression analysis is performed to optimise the values of the coefficients of each of the variables in the energy model.

Table B.1 provides a suggested approach to regression analysis when it is being used in an energy model (like that being developed in Table A.1). Regression analysis can be used to establish the baseline and operating energy model for an Implementation, to meet the requirements of the ESS Rule.

B.2 Establishing energy models by computer simulation

Computer simulation can be used to establish an energy model for an implementation that estimates the energy consumption using a number of independent variables and site constants that vary over time.

The energy model will be established for:

- baseline conditions, before implementation (forward creation and top-up sub-methods), and
- operating conditions, after implementation (for forward creation sub-method).

The energy model expresses the energy consumption as a mathematical function of the independent variables and is used to perform "routine adjustments" as defined under the IPMVP.

Requirements

To use computer simulation, the ESS Rule requires the use of software that:

- is commercially available
- is approved by the Scheme Administrator for use in modelling the relevant type of end-user equipment
- is calibrated against measurements taken from the actual end-user equipment being simulated to meet requirements as published by the Scheme Administrator, and
- can be tested against requirements published by the Scheme Administrator.

If you propose to use computer simulation to calculate energy savings, please contact IPART prior to submitting an application for accreditation. You can propose the software package to be used to develop your energy models, however the Scheme Administrator will need to consider the validity of its use on a case-by-case basis.

When assessing the use of your chosen software package, the Scheme Administrator may assess it using the guidelines described in Table B.2.

Table B.1 Suggested approach for establishing energy models by regression analysis

Step	Description	Details
1	Measure energy consumption and site variables over the measurement period	Define the start date and end date of the measurement period. ▾ Measurement periods are required before implementation (baseline conditions) and after implementation (operating conditions). ▾ Ideally the measurement period should define a full operating cycle of the end-user equipment. ▾ If a measurement period is shorter than a full operating cycle, there is a risk that the data collected over the measurement period will not be representative of the full operating range of the equipment and the Independent Variables and Site Constants – this has implications in determining the Effective Range. ▾ Measure energy consumption and all Independent Variables and Site Constants for the set measurement period.
2	Remove measurements taken under non-normal site conditions	Non-routine adjustments account for those characteristics of a facility which affect energy use, within the chosen measurement period, that are not used as the basis for any Independent Variables or Site Constants. ▾ Record any non-routine adjustments of measured data, where time periods that cover non-routine events (eg, unscheduled maintenance) are excluded from all measurements. ▾ Calculate the non-routine adjustment ratio as the percentage of measurements removed from total number of measurements taken within the measurement period.
3	Test for correlation between Independent Variables	It is important that the variables used in the energy model are independent of one another, since co-dependence will result in poor regression parameters and introduce unnecessary complexity to the energy model. ▾ Test for correlation between the measured values for the variables, for example by calculating the Pearson's correlation coefficient. ▾ Review any variables that are strongly correlated and consider refining your regression model. ▾ If using the OEH PIAM&V Tool, this function is performed in the tool using the CORREL function. ▾ The Effective Range is to include any normal year values for Independent Variables or Site Constants under which the Implementation could reasonably be expected to increase energy consumption.

Step	Description	Details
4	Determine Effective Range	The Effective Range is the range of values over which the energy models are valid. ▾ Each Independent Variable and Site Constant used in an energy model must have an accompanying Effective Range. ▾ The Effective Range needs to be consistent with the range of measured values for Independent Variables and Site Constants. ▾ Techniques for determining the Effective Range are provided below in Steps 4a, 4b. ▾ Other methods for determining the Effective Range may be considered.
4a	Method to determine Effective Range – Bounding Box	The OEH PIAM&V Tool uses a bounding box of all of the measured values of each Independent Variable to determine its maximum and minimum values, the values being: ▾ $x_{j.max}$ = max(x_j(t)), and ▾ $x_{j.min}$ = min(xj(t)), ▾ where xj(t) is the value of the Independent Variable x_j measured during the relevant time period.
4b	Method to determine Effective Range – Convex Hull	A convex hull method can be used to incorporate all of the measured values of an Independent Variable to define the Effective Range. ▾ The convex hull method determines an equation, or range, that describes a single or multi variable region within which all the measured values exist.
5	Using regression analysis to estimate energy model	Regression analysis may include linear and non-linear multivariate regression techniques. You can use the OEH PIAM&V Tool to record the data and calculate energy savings, however: ▾ the regression analysis must be calculated outside of the tool ▾ it can only accept linear regression equations, and ▾ non-linear regression analysis must be conducted outside of the tool using appropriate software or tools. You can also use your own calculation spreadsheets to calculate the energy savings. When you submit your energy model and evidence to support the calculation of ESCs, you should provide at least the following, describing their use and any assumptions in the M&V Plan (or similar): ▾ the software/tool used to conduct the regression analysis ▾ the value of the regression coefficient for each variable and associated t-statistic ▾ the coefficient of determination (R^2) and adjusted R^2, and ▾ the standard error (SE) of the regression equation.

Table B.2 Guidelines for the use of computer simulation (using a commercially available software package determined to be acceptable by the Scheme Administrator)

Requirement	Information provided by applicant	Guidelines that may be used by Scheme Administrator to assess requirement
Commercially available & models relevant type of end-user equipment	Name and version of model	▾ List of programmes on US Dept. of Energy at: http://apps1.eere.energy.gov/buildings/tools_directory/ ▾ Validated using IEA-BESTest protocol.
Calibrated against measurements taken from the actual end-user equipment being simulated	▾ Calibration data ▾ M&V Professional ability to calibrate outputs from computer simulation	▾ Calibration using ASHRAE 14 Guideline – 2002. ▾ Other applicable standards. ▾ Relevant skills, experience or qualifications of M&V Professional.

C Fuel switching activities

Under clause 5.3 of the ESS Rule, fuel switching (from electricity to gas or from gas to electricity) that increases the efficiency of energy consumption may constitute a RESA, provided the activity meets certain criteria.

Figure C.1 may assist potential applicants for accreditation to determine if a proposed fuel switching project is eligible to be treated as a RESA under the ESS.

Some project examples are included in Table C.1 and C.2 for further reference.

Figure C.1 Flowchart of eligible fuel-switching activities

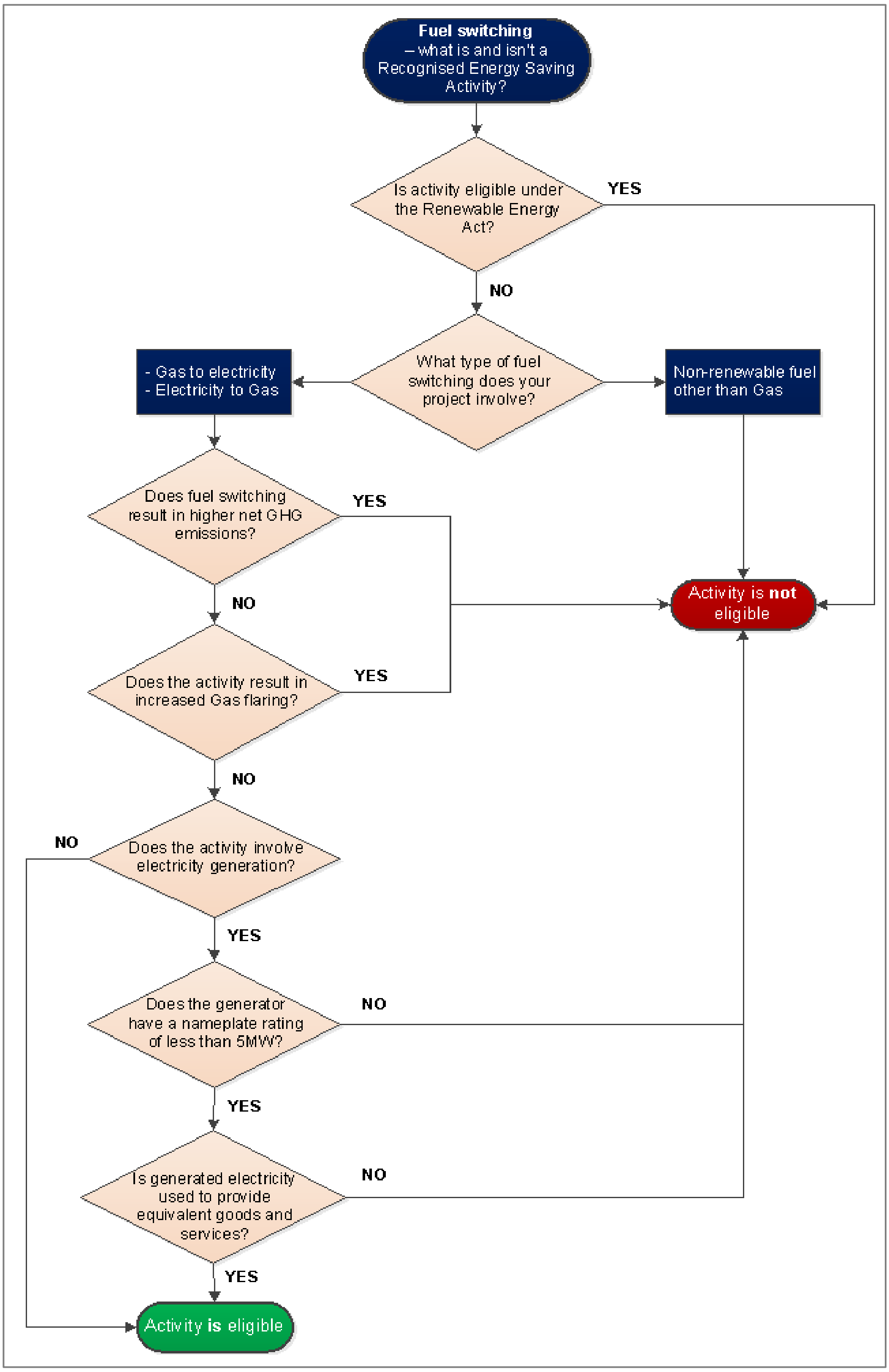


Table C.1 Examples of fuel switching activities eligible under the ESS

Eligible Activity	Example
Gas to Electricity	▼ Replacing gas-fired heating equipment with electric heating equipment.[56]
Electricity to Gas	▼ Installing a gas engine, cogeneration or trigeneration unit with a power generation capacity of less than 5MW, where all generated electricity is used onsite for the production of goods and/or services (ie, no power exports). ▼ Replacing electric heating equipment with gas-fired equipment.[57] ▼ Replacing an electrical drive or electrically driven equipment[58] with gas-powered equipment.

Table C.2 Examples of fuel switching activities not eligible under the ESS

Ineligible Activity	Examples
Gas or electricity to other fuels (renewable and non-renewable)	▼ Replacing a gas-fired boiler with a: ▾ coal-fired boiler ▾ biogas-fired boiler ▾ biomass boiler ▼ Retrofitting a dual gas burner on an existing boiler to replace natural gas with biogas.
Fuel switching that results in an increase in flaring	▼ Replacing a biogas-fired heater with an electric heater resulting in increased biogas flaring as less biogas is used (where biogas is generated onsite).
Fuel switching that results in an increase in net Greenhouse Gas (GHG) emissions	▼ Removing a gas cogeneration system to reduce gas consumption resulting in higher purchased electricity use and increased net GHG emissions. ▼ Retrofit a dual gas burner on an existing cogeneration system to co-fire coal seam gas and reduce natural gas consumption. The switch to coal seam gas will result in higher GHG emissions due to the higher emission factor of coal seam gas compared to natural gas.
Fuel switching activity that is eligible to create tradeable certificates under the *Renewable Energy (Electricity) Act 2000*	▼ A 1MW biogas electric generator, which is eligible to create Large-scale Generation Certificates (LGCs) under the Renewable Energy Target (RET) scheme. Biogas is an eligible renewable energy source under the RET scheme to create renewable energy certificates.
Electricity generation where any generated power is not used to provide equivalent goods or services	▼ A 4MW cogeneration system that supplies more than 100% of a site's electrical consumption with the excess power exported to the grid.

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[56] Such as a furnace, water heater or steam producer using eg, a resistance, induction or microwave heater.

[57] Heating equipment such as a furnace, kiln, dryer, water heater or steam generator.

[58] Such as air-conditioning systems, refrigeration compressors or pumps.

Ineligible Activity	Examples
Electricity generation from a generating system that has a nameplate rating greater than 5MW	▼ A 6MW cogeneration system running at 80% capacity. Though the power output is less than 5MW the nameplate rating is greater than 5MW.

D Technical guidance

D.1 Introduction

Clause 7A.16 of the ESS Rule provides that the Scheme Administrator may publish guides that detail acceptable and unacceptable approaches for ACPs and M&V Professionals to meet the requirements of the PIAM&V method.

This technical guidance provides ACPs with information on acceptable approaches for the development of M&V plans, which is a key requirement under the PIAM&V method.

An M&V plan template has been developed in conjunction with this document,[59] which can be used by ACPs when applying for accreditation or when preparing records to support any ESCs created using the PIAM&V method. An example of a completed M&V Plan can also be found in Appendix E.

D.2 Overview of the PIAM&V process

The PIAM&V method allows for energy savings to be calculated using one of three approaches:[60]

- forward creation of ESCs from a single site calculated from a baseline energy model and operating energy model (modelling energy performance before and after project implementation)
- annual creation or top-up of ESCs based on actual performance of a project following implementation, and compared to a baseline energy model, or
- multiple site ESC creation based on a baseline energy model and operating energy model, and using a sampling method approach.

Figure D.1 below outlines the general PIAM&V process, detailing the stages required for forward and annual ESC creation.

The PIAM&V process requires ACPs to define a number of parameters at each of these stages. These parameters are described in more detail in the following sections.

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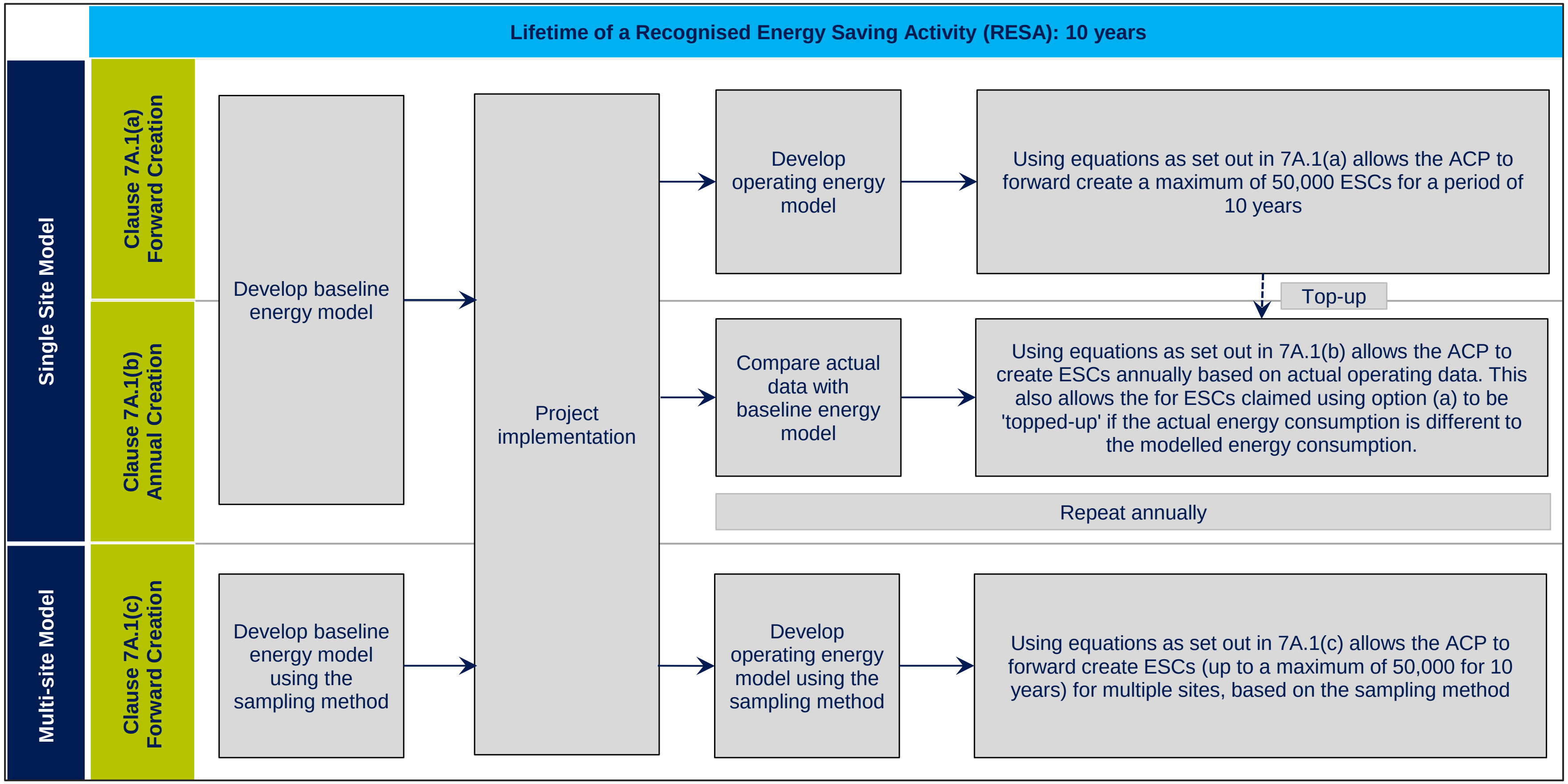
59 Available at www.ess.nsw.gov.au/Methods_for_calculating_energy_savings/Project_Impact_Assessment_with_MV.

60 *ESS Rule*, cl 7A.1

Figure D.1 A typical PIAM&V timeline



D.3 Developing energy models

Method Guide – section 2.1

"There are four acceptable types of energy models that may be used to model energy use and calculate energy savings: estimate of the mean, regression analysis, computer simulation and sampling method."

The ESS Rule requires that the following parameters are considered and established to support the development of the baseline and operating energy models:

- measurement boundary
- choice of independent variables and site constants
- effective range, and
- project implementation date.

D.3.1 Establish the measurement boundary

Method Guide – section 3.7

"When establishing energy models, the measurement boundary needs to be established. This determines what equipment and parameters will be included and excluded from the energy savings calculations. It effectively sets a boundary for the energy models."

ACPs will need to demonstrate an understanding of the end-user equipment (**EUE**) and proposed activities that will result in energy savings, as well as the site specific operating environment, in order to select an optimal measurement boundary. The boundary determines the physical scope of an implementation and its associated energy model(s). The effects of a RESA are therefore determined at this boundary. The choice of measurement boundary is a key consideration influencing the complexity and accuracy of measuring energy savings associated with a RESA. Some scenarios are illustrated in Figure D.2 and Figure D.3 below.

Figure D.2 Example measurement boundary around entire building

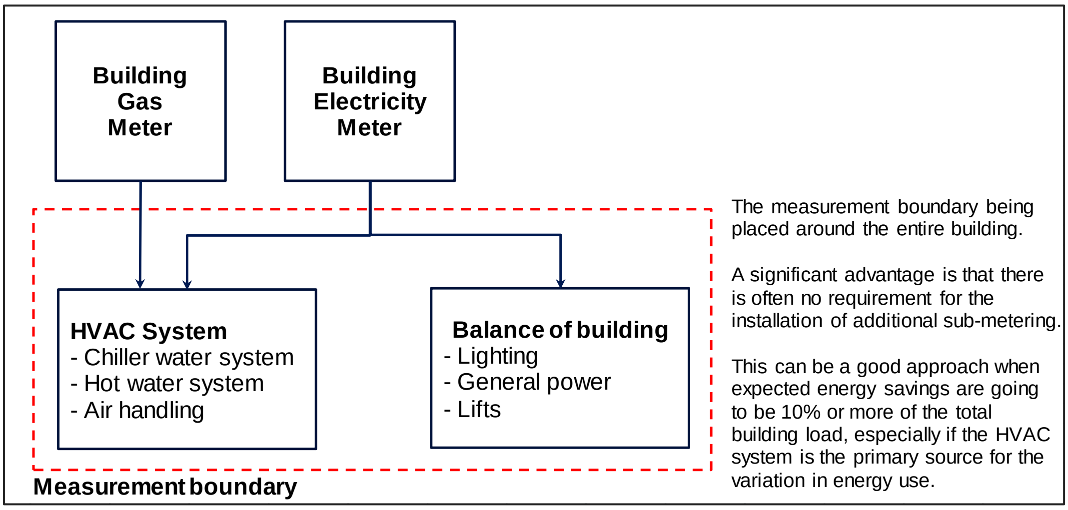
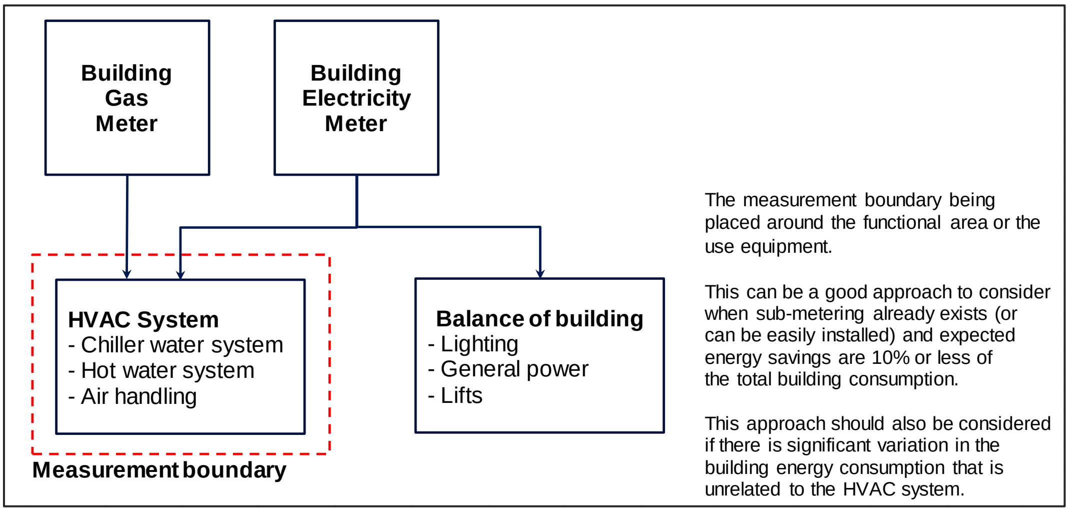


Figure D.3 Example measurement boundary around functional area



For each implementation, ACPs must justify the appropriateness of their choice of measurement boundary for the RESA, with specific reference to:

- the effective range of the energy models (refer section D.3.4)
- the size of the estimated savings relative to the energy consumption within the defined boundary, and
- how the energy consumption outside the measurement boundary changes as a result of the RESA (refer section D.4.2).

The choice of measurement boundary will also determine what the independent variables and site constants are for the energy model. In the examples in Figure D.2 and Figure D.3 independent variables are likely to be temperature and occupancy related. With the whole of site measurement boundary in Figure D.2, the temperature related independent variables could be cooling degree days and heating degree days. However, for the functional equipment measurement boundary in Figure D.3, the temperature related independent variables could be flows of chilled water and hot water.

As a guide only, ACPs should be aiming to set the boundary so that the expected energy savings are greater than or equal to 10% of the predicted energy performance within the measurement boundary.[61] For values less than this it can be difficult to differentiate between actual savings and the unexplained variance using the energy models.

Both effective range and interactive effects will influence the total energy savings that may be calculated from an implementation. If interactive effects are likely to be substantial, a larger boundary is recommended. Under certain circumstances it may even be justifiable to extend the boundary further to represent the total facility. Alternatively, ACPs could develop the relationship between energy consumption, energy savings and interactive effects.

Further guidance on establishing the measurement boundary can be found in section 4.1.2 of the OEH *Measurement and Verification Operational Guide – Best practice M&V processes*.[62]

D.3.2 Define variables

Method Guide – section 0
"The calculation of energy savings under this method (…) requires independent variables and site constants to be determined and included in the energy models."

A key component of developing an appropriate energy model involves the identification and use of relevant project variables.

ACPs should ensure that their methodologies take account of these site specific variances. This is particularly important if the method is, or will be, used for multi-site sampling approaches. Therefore, in addition to the general performance characteristics of the EUE and equipment used to modify systems, ACPs should consider the effectiveness of a RESA with reference to the interplay between the EUE and site specific characteristics.

61 Refer to the *International Performance Measurement and Verification Protocol, Concepts and Options for Determining Energy and Water Savings, Volume I, 2012*

62 Available at www.environment.nsw.gov.au/energyefficiencyindustry/confirm-energy-savings.htm

Typically this would include the calculation of the standard load requirement of the site, and identification of factors that will impact on the site's final load requirements, including:

- independent variables, such as operating hours, production levels, service levels, and external factors (eg, climate), and
- site constants, including:
  - static factors, such as one-off changes (eg, maintenance shut down) or permanent changes (eg, building expansion), or
  - design features (eg, HVAC temperature set points and dead bands).

ACPs and M&V Professionals need to consider these site specific variables when developing or evaluating baseline and operating energy models, as performance efficiency of EUE may vary significantly across sites, based on site-specific independent variables and site constants.

Further information on potential independent variables and site constants for common technologies and RESAs is included in section D.5.

Independent variables

Independent variables are parameters that explain how energy consumption changes over time under normal operating conditions. They are used in baseline and operating energy models to estimate energy consumption. As they are inputs to the energy models, it is essential that they can be measured and monitored for data collection purposes.

The location of the variables may be external to a site or within the site, though not necessarily within the measurement boundary. Typical independent variables that applicants should consider when using the PIAM&V method include:

- nature based (eg, ambient temperature, humidity, rainfall, wind speed/direction)
- site specific (eg, occupancy, operating hours, visitors/customers), and
- system specific (eg, production line output, raw materials, purity, moisture content).

Independent variables must be measured during the same period of time as the energy consumption measured. However, the nature of the independent variables and site constants influence the duration of a typical 'business cycle' for which baseline and operating energy data should be collected. Ideally, data to inform the development of baseline and operating energy models should be collected over the full range of normal operating conditions. If independent variables are not measured over the full range of normal operating conditions, this can limit the effective range and the energy savings for the implementation (see section D.3.4)

Included below is additional guidance on approaches for identifying independent variables.

Identification of independent variables

While the choice and applicability of independent variables in the development of a good energy model can be a simple process, this is not always the case.

ACPs should ensure they have a good understanding of how energy is used on site, or in relation to a particular piece of equipment, prior to identifying variables. This will ensure that the most appropriate independent variables are selected for a project.

Some approaches for understanding site energy consumption include:

- energy audits
- analysis of collected data, and
- graphical representation of data.

It will normally be necessary to use a combination of the above methods and it is often an iterative process. An overview of these methods is included in Table D.1 below.

Table D.1 Methods for understanding site energy consumption

Method type	Site energy consumption approaches
Energy audit	Site energy consumption can be determined through an energy audit[63] which seeks to identify: 1. All incoming energy flows (eg, gas, electricity) 2. All energy using equipment (eg, motors, lights, air compressors) 3. Data associated with how the equipment is operated and its influence on energy consumption (eg, operating hours, production, on demand, occupancy) The results of the last step may reveal certain parameters or operating conditions that have a major influence on the energy consumption and should be considered as independent variables.
Analysis of the collected data	There are a number of steps that should be conducted on any collected data before attempting to establish if there is a sufficient relationship to develop an energy model. These include:

63 The AS/NZS 3598 Energy Audits Standard sets out the requirements for commissioning and conducting energy audits, and identifying opportunities for cost effective investments, to improve efficiency and effectiveness in the use of energy.

Method type	Site energy consumption approaches
	▼ For each measured parameter, does each data point represent the same time period? For example, some Supervisory Control and Data Acquisition (**SCADA**) systems will record values only on change by a certain percentage amount rather than at set time periods. Alternatively there may have been errors in the recording of data, resulting in missing or mismatched values (eg, SCADA daily totaliser failed to write to disk at midnight, resulting in the subsequent day's total value representing two days of data). ▼ Does each measured parameter use the same time interval (eg, SCADA value every 5 minutes compared to energy consumption data of every 30 minutes)? If not, data aggregation is required to ensure that the frequency of the energy consumption values is the same in the measurement period. ▼ Examine the data for outliers, or non-routine events, and investigate possible reasons. These may be the result of abnormal operating conditions, not modelled by independent variables or site constants, or the result of bad data which may warrant either the exclusion of the value or a manual adjustment of the value. This ensures a like for like comparison of energy savings before and after the implementation. The percentage of time excluded must be less than 20%[64] of the measurement period. **Ensure that you document any data that is removed or modified from the measured data set** ▼ Where some data is at too large a time interval compared with other measured data onsite (eg, monthly electricity consumption based on utility invoicing versus production data that can be highly variable on a daily basis), an ACP may want to consider installing additional metering to gain data at a higher frequency interval for all data points. There are no minimum requirements for the frequency of the data, however the granularity of data will impact on the regression values, and the development of the baseline and operating energy models, as the largest time interval of any of the measured parameters determines the frequency for the final energy model. ▼ Once data is all of the same time interval, consider aggregating into different time periods (eg, if you currently have data for every 30 minute interval, consider aggregating into daily, weekly or monthly time intervals). This can be a useful step when data is highly irregular or seemingly random at too fine a time period (eg, refrigeration motors or compressors cycling on and off). In these instances a greater sense of uniformity in the data can be gained when the data is examined over a longer time period.

64 *ESS Rule,* cl 7A.5(g)

Method type	Site energy consumption approaches
Graphical representation of data	Once the data has been assessed and processed, charts should be used to graphically represent the data in the form of XY scatter plots against energy consumption. This is not a requirement, but can assist with the visualisation of data and establishment of regression values (where a regression model is used). This should be conducted with each measured variable and for different time periods to confirm where possible relationships may exist to inform the selection of an independent variable. Importantly, observe the scatter in the data and look for multiple groupings of data, which may suggest the inclusion of additional variables relating to the selected data. This should be investigated further by categorising the data into the two or more groups and investigating possible reasons for differences in values. Some examples of common additional categories that could be encountered include: ▼ energy related to the operating hours of electric motors, with additional categorisation based on two different production modes, or ▼ building energy consumption being strongly correlated to ambient temperature with additional categorisation based on certain days of the week (eg, working versus non-working days, or certain events being held every Tuesday). The desired output is a shortlist of possible measured parameters that appear to show some relationship with energy that should be considered when developing the energy model.

Site constants

Site constants are parameters that may vary between sites and influence energy consumption within the measurement boundary, but are expected to remain constant under normal operating conditions. Some common examples include operating hours and net lettable area in commercial buildings, or control set-points in production based facilities.

For a single site model, the site constants must not change during the measurement periods that are used to establish the baseline and operating energy models.

The site constants must also be measured over the life of the project, and any time periods where the site constants are not their standard value must not be included in the energy saving calculation.

If the site constants are expected to change, then they should be included as independent variables, or the measurement boundary of the project adjusted so that the change does not affect the energy consumption being measured. For example, if a new building was built on the site in the example in Figure D.2 and connected to the same site utility meter, the whole of site approach would include this new building energy consumption and the site constant of 'building area' would change. However, if the measurement boundary was around the HVAC system of the existing building only, as per Figure D.3, then the new building would not affect the site constants or energy consumption.

Suggested independent variables and site constants for common technologies and RESAs, which should be considered under the PIAM&V method, are included in Appendix A. ACPs should demonstrate that they have considered these variables as inputs for the energy model. If they are found to have little impact on variances in energy consumption, ACPs should provide justification for not incorporating them in the model (eg, an independent variable may be excluded if is shown to not significantly affect energy consumption by returning a low t-statistic in the regression modelling).

D.3.3 Energy models

Method Guide – section 0

"The calculation of energy savings under this method is based on comparing the results of a baseline energy model with those from an operating energy model."

To determine the energy savings associated with an implementation, the first step when conducting M&V is to develop a baseline energy model. This establishes an understanding of what the energy consumption would have been if the RESA had not been implemented. Savings are then determined by one of the following:

- the difference between the energy consumption estimated by the baseline energy model and the operating energy model, for forward creation of ESCs, or
- the difference between the energy consumption estimated by the baseline energy model and actual measurements taken after the implementation under the same conditions, for annual creation or top-up.[65]

Developing an energy model is generally done using linear regression with one or more independent variables, but can also be done using non-linear regression, an estimate of the mean or computer simulation methods.

It may be necessary to develop multiple energy models to determine the best combination of independent variables and different time intervals that results in the optimal energy model.

65 To determine energy savings, the normal year, interactive savings, accuracy factor, decay factor, persistence model and counted energy savings will need to be defined too. These parameters are described in section D.4.

Depending on the project, the baseline and operating energy models may be based on the same or different independent variables and site constants. Likewise, the method used to develop the energy models may be the same or different for the baseline and operating energy models. Note that if the baseline and operating energy models have different independent variables and site constants, normal year values for all of the independent variables and site constants must be specified to calculate normal year energy savings.

Section 2.1 outlines the four acceptable energy model types under the PIAM&V method. The two types of method most commonly used, regression analysis and estimate of the mean, are described in the sections below.

Regression analysis

Regression analysis is a statistical process for estimating the relationship between a dependent variable, in this case the energy consumption, and one or more independent variables. For models that have only one independent variable, this is called simple linear regression. For models that have more than one independent variable, the process is called multiple linear regression.

Table D.2 presents some guidance on thresholds of statistical good-fit that could be used by ACPs in developing an energy model using linear regression.

Table D.2 Guidance for determining the statistical validity of energy models developed using linear regression

Modelling criteria	Definition	Threshold
t-statistic of independent variable	The t-statistic is a measure of the statistical significance of each independent variable.	Absolute value > 2
Adjusted R^2 (coefficient of determination)	The R^2 is a measure of the suitability of a set of data to a fitted regression model.	> 0.75
Relative precision calculated at 90% confidence level	The relative precision is a measure of how much the predicted value from the baseline or operating energy model is predicted to vary from the true value. The relative precision of the baseline and operating energy model both influence the relative precision of the savings estimate, which then is used to calculate the accuracy factor (section D.4.3 of this guide).	Within ±200%

The relative precision of the baseline and operating energy model both influence the relative precision of the energy savings estimate.

The relative precision of the energy savings estimate is used to calculate the accuracy factor used to discount savings, as discussed in section D.4.3 of this guide, and must be within ±200%. Values exceeding this threshold will result in an accuracy factor of zero and will not result in any energy savings.

There can be a range of reasons that result in an adjusted R^2 below 0.75 or cause the relative precision to be too large, including:

- too much random variation occurring within the site or system
- inclusion of abnormal events / operations within the period from which data has been collected that need to be removed or accounted for
- time interval is too fine or too coarse
- not all independent variables have yet been identified, or
- the inclusion of variables that do not provide a strong relationship with the energy consumption (generally where the t-statistic for the variable is less than 2).

ACPs 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.

An example of a regression model for an HVAC system is provided in Box D.1.

Box D.1 Regression model example

An energy model for a HVAC system will typically be established using linear regression analysis which relates energy consumption to independent variable(s) such as the number of Cooling and/or Heating Degree Days (CDDs and/or HDDs), as well as occupancy levels. A basic HVAC simple linear regression model based on one independent variable may be presented as follows:

$$\boldsymbol{Y = a + b_1 X}$$

Where:

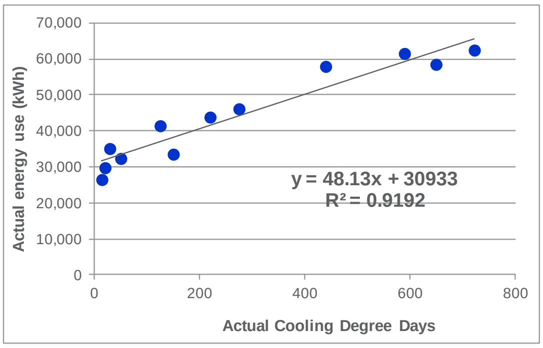
Y = Estimated electricity consumption (kWh)

X = CDD, the variable used to predict Y

a = y-intercept coefficient = baseline electricity consumption

b_1 = the slope coefficient of the CDD

A typical representation of the strength of the relationship is provided below. This example shows a good correlation between electricity consumption and CDD, with R^2 = 0.9192. This indicates that the methodology is adequate and that the cooling system is working well (the 'control' of the system is good, with a reasonable CDD base temperature).



Estimate of the mean

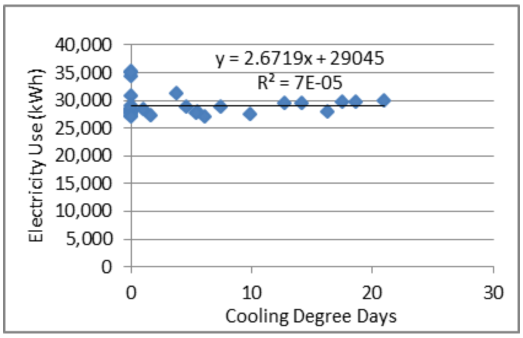
It is not always possible to develop a satisfactory energy model where there are no independent variables that significantly affect energy consumption. In this case, a graph of energy consumption over time will show that there is little variation in energy consumption, and using a regression analysis with any combination of independent variables will give an R^2 value close to zero. In these circumstances, it may be necessary to use the estimate of the mean approach where the energy model uses a single value for an estimate of the energy consumption that is calculated from the mean energy consumption over the measurement period.

A key requirement when developing an energy model via this approach is that the coefficient of variation of the energy consumption over the measurement period is less than 15%.[66] The coefficient of variation is defined as the sample standard deviation expressed as a percentage of the sample mean.

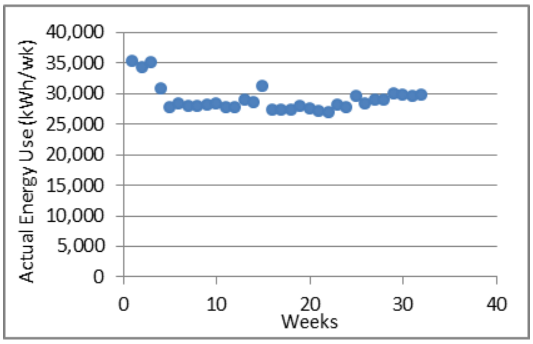
An example of an estimate of the mean for an HVAC system is provided in Box D.2.

Box D.2 Estimate of the mean energy model example

In this case, the graph of electricity consumption against cooling degree days shows that there is little variation in electricity consumption that is explained by this independent variable, and the R^2 value is close to zero. Before determining if the use of an estimate of the mean energy model is appropriate, it is necessary to analyse the system to determine if there are other independent variables that significantly affect electricity consumption. Note that it may be necessary to measure likely independent variables to determine that they do not have a significant effect on the energy consumption. This should be considered in the M&V design.



In this case, the electricity consumption over the time period measured is relatively constant, indicating that it may be appropriate to use an estimate of the mean energy model.



The mean weekly energy consumption is 29,057 kWh, with an accompanying standard deviation of 2,177. This results in a coefficient of variation of 7.5%, meaning that it still qualifies for use under the estimate of the mean approach.

This is a typical example of a system running at full capacity (eg, a ventilation fan), where the energy consumption does not vary significantly with any independent variables, meaning the estimate of the mean method may be used to develop the baseline energy model.

66 *ESS Rule,* cl 7A.2(a)(i)

After the project is implemented (eg, installation of a control system upgrade), the energy consumption of the equipment may be influenced by an independent variable (eg, temperature or production). As such, linear regression may be used to develop the operating energy model. This shows that independent variables do not have to be the same for both baseline and operating periods. Likewise, the energy models for both periods may be developed using different methods.

D.3.4 Effective range

The effective range defines the range over which the energy model has been developed and is therefore valid in terms of predicting future performance. The PIAM&V method does not allow for the extrapolation of the model beyond the range of data, extended by ±5%,[67], from which it was created.

It is advisable to select a measurement period that covers a wide range of possible operating conditions, hence values of independent variables, so that the energy model can be used with greater confidence in predicting future performance. ACPs should consider the effective range of the independent variables for both baseline and operating energy models in conjunction with the range of the independent variables in the normal year established for the site. This is because energy savings are not able to be calculated for any normal year values that fall outside the effective range (extended by ±5%) of either the baseline or operating energy models.

For commercial buildings or other sites that have energy models that use ambient temperature, or related variables such as cooling degree days, as an independent variable, between 6 - 12 months of data may be needed to maximise the effective range of the energy model.

For independent variables that are within the control of the project developer, for example production, project developers may wish to consider running the energy using process at values of these independent variables towards their limits during the measurement period, to maximise the effective range. Care must be taken to ensure values chosen are still within the normal operating conditions for the site.

Under the forward creation for a single site model approach, if a limited range of data is used to establish the effective range, ACPs will forego possible energy savings when the normal year value for any independent variable lies outside the effective range (extended by ±5%) of either the baseline energy model or

[67] *ESS Rule*, equation 7A.2

operating energy model.[68] ACPs will need to balance the cost of collecting additional data versus the possible additional savings to be claimed.

It is important to note that energy models developed using the estimate of the mean method do not have an effective range applied, as they do not have any independent variables. As such, baseline or operating models developed using this method (that meet all ESS Rule requirements, including the test on coefficient of variation) will not have energy savings limited by the effective range. Site constants are still relevant however, and energy savings are zero for any times that the site constants are not their standard value.

An example of how the effective range is determined for an industrial application is provided in Box D.3.

Box D.3 Effective range example

In this example an upgrade of an industrial process results in both a reduction of electricity consumption (due to implementation of energy efficient equipment) and an increase in production levels (due to increased capacity of the new equipment installed).

The independent variable (monthly production) is measured over 12 months before implementation and then for 12 months post-implementation.

The recorded production values are shown below:

Baseline Period			Operating Period		
Month	**Production (tonnes/month)**	**Electricity consumption (MWh/month)**	**Month**	**Production (tonnes/month)**	**Electricity consumption (MWh/month)**
Jan-14	1,892	2,661	Jan-16	5,558	7,211
Feb-14	1,779	2,667	Feb-16	1,155	1,583
Mar-14	2,917	4,196	Mar-16	1,917	2,398
Apr-14	2,270	3,563	Apr-16	5,674	7,351
May-14	1,190	1,727	May-16	1,292	1,623
Jun-14	1,271	1,715	Jun-16	4,882	6,293
Jul-14	2,407	3,533	Jul-16	4,609	6,187
Aug-14	1,568	2,177	Aug-16	3,817	5,045
Sep-14	2,891	4,536	Sep-16	3,176	4,062
Oct-14	2,474	3,873	Oct-16	3,643	4,703
Nov-14	2,036	3,145	Nov-16	1,566	1,928
Dec-14	2,274	3,348	Dec-16	5,973	7,725
Min	**1,190**		**Min**	**1,155**	
Max	**2,917**		**Max**	**5,973**	

In this case, the normal year has been determined based on historical production as well as forecasted production levels post-implementation. Monthly production values in the normal year (12 months) range between 1,000 and 6,500 tonnes.

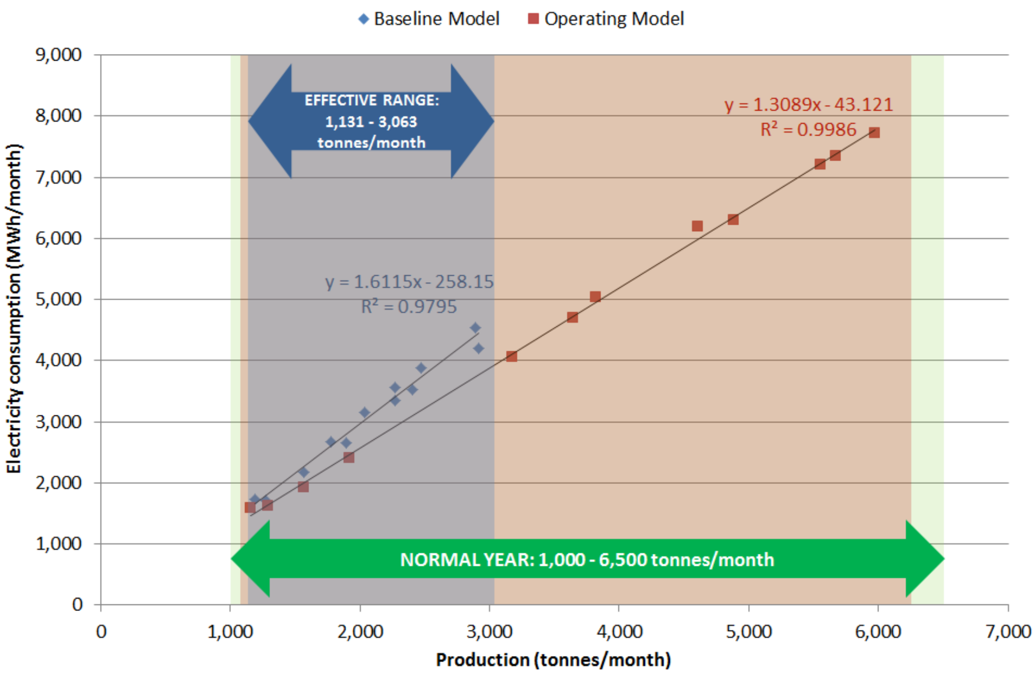
The range for which normal year energy savings can be calculated is determined by

68 Note that ESCs foregone due to a limited effective range of the operating energy model may still be claimed by ACPs using top-up applying equations 7A.3 and 7A.4. This will require the ongoing measurement of electricity and gas consumption following implementation.

intersecting the effective ranges of the baseline and operating energy models and the range of the normal year.[69] In this case, it is limited by the baseline energy model effective range:

Period	Production (tonnes/month)	
	Min	Max
Baseline effective range	0.95 *x* 1,190 = 1,130.5	1.05 *x* 2,917 = 3,062.8
Operating effective range	0.95 *x* 1,155 = 1,097.2	1.05 *x* 5,973 = 6,271.6
Normal year values	1,000	6,500
Range over which normal year energy savings can be calculated	**1,131**	**3,063**

The determination of the effective range is graphically represented in the chart below:



In this case, although the normal year considers increased production levels occurring as a result of increased capacity of the upgraded process, the effective range is limited by the baseline period range.

If it is known that the range of values for independent variables in the normal year is likely to increase, savings can be maximised by focusing on extending the effective range of the energy models where possible. An example could be a manufacturing line that is originally only forecast to run at a maximum of 70% capacity during the chosen baseline measurement period. The project developer, with approval of the site owner, could then schedule a production run at 100% capacity during a measurement period in order to record values of the energy consumption and independent variables at this limit, and extend the baseline effective range.

69 The OEH PIAM&V Tool provides an acceptable approach for determining the effective range.

D.3.5 Project implementation

Method Guide – section 3.7
"To establish a working energy model, the time period over which measurements are taken must also be established, including the start date and end date of the measurement periods."

The baseline energy model must use a baseline measurement period with an end-date before the implementation date. Similarly, both the operating energy model and measured annual electricity or gas savings require a measurement period with a start date occurring after the implementation date.[70] The implementation date is the date that the implementation commences normal operations.[71]

It is advised that projects where commissioning or other post implementation issues may occur are allowed time to become 'embedded' into normal operations before any post implementation data is collected for the operating energy model or measured annual electricity or gas savings, so as to allow for any issues to be resolved.

D.4 Determining energy savings

The calculated 'lifetime' energy savings are based on the expected life of the end user equipment (to a maximum of 10 years) and the following additional factors:

- a normal year, which is defined as a typical year of operation of the end-user equipment at a site, after the implementation date
- any interactive energy savings, which are changes to a site's energy consumption that are due to the implementation, but that occur outside of the measurement boundary
- an accuracy factor, with a value between 0 and 1, is used to discount the energy savings according to the relative precision of the calculation of the energy savings
- a decay factor, either from a persistence model or from default values, is used to discount the normal year energy savings to calculate the lifetime energy savings, and
- any counted energy savings from previous ESC creation for the RESA or at the same site from another RESA (or corresponding scheme), which must also be deducted.

70 The only exception is for top-up creation (clause 7A.14), for which measurements are done annually and the start date must fall on an anniversary of the implementation date. This means that the start of the top-up measurement period for year one is the implementation date.

71 *ESS Rule,* cl 7A.17

D.4.1 Normal year

Method Guide – section 3.7

"The energy savings from an implementation are calculated for savings over a normal year (normal year energy savings). A normal year is defined as a typical year of operation of the end-user equipment at a site, after the implementation date.[72]"

This step requires ACPs to define the data that forms a 'normal year of operating conditions' for the purposes of predicting the energy savings due to the implementation over the lifetime of the project. Note that a normal year is not required for annual creation of ESCs.

This is achieved by specifying 12 months of data for each independent variable at the same measurement frequency as data used to develop the baseline and operating energy models.

This data is then used as inputs into the baseline and operating energy models for the purpose of estimating business as usual (baseline) and post-implementation (operating) energy consumption on a like-for-like basis, so that energy savings can be estimated. The normal year values must represent a typical year of operation for the end-user equipment over the life of the project (maximum time period for forward creation).

Where the operating cycle of the system is less than one year, the normal year may be constructed by combining values from multiple operating cycles to make up one year of data representative of a typical year of operation.

When defining a normal year, ACPs must:

- consider future 'typical' operating conditions, which may differ from the baseline period; operating conditions may include typical weather conditions, operating days per year, maintenance periods, or changes in site activities (eg, production levels)
- use actual data, rather than estimates, where practical (eg, manufacturing records); typically, data should not be older than three years to be representative of future operating conditions, and
- describe how the normal year is constructed, noting any adjustments, calculations or manipulations.

72 Clause 7A.12 of the ESS Rule defines the maximum time period for forward creation.

D.4.2 Interactive energy savings

Method Guide – section 3.7

"The interactive energy savings must be estimated and added when determining the normal year energy savings. Setting the correct measurement boundary is important as the energy models also need to account for interactive energy savings. These are changes to a site's energy consumption that are due to the implementation, but that occur outside of the measurement boundary."

Based on the identification of any interactive effects, this step involves establishing an energy model that describes how energy consumption outside the measurement boundary changes as a result of the RESA.

Some interactive effects are well known and understood and it may be possible to draw on external sources of documentation in defining the interactive energy model. A common example of an interactive effect is a lighting upgrade and the resultant change in HVAC requirements. In this case, the HVAC system is considered to be outside the measurement boundary. A change to more efficient lighting will decrease the heat load on the HVAC system, and reduce the energy required for cooling, but increase the energy required for heating. The overall size of the interactive effect is dependent on the proportion of time the HVAC system is cooling and heating.

Another example involves the utilisation of waste heat from a boiler or compressed air system. This could reduce the plant room air temperature which may reduce the operating hours of temperature dependent plant room exhaust fans.

The ESS Rule requires that the interactive electricity savings and interactive gas savings account for no more than 10% of total electricity savings and gas savings respectively, unless estimated in accordance with a guide published by the Scheme Administrator.[73] The OEH PIAM&V Tool provides an acceptable approach for estimating interactive effects on HVAC systems if the EUE is within an air conditioned space.

In some circumstances, it may be necessary to conduct a number of trials with data logging on a variety of EUE that is outside the measurement boundary to generate enough data for an interactive energy model to be developed (possibly using the same regression analysis techniques already used to develop the baseline and operating energy models). However, this approach creates significant complexity for the RESA and ACPs and is generally not recommended.

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73 *ESS Rule*, cl 7A.9(c)

In all circumstances, it is desirable that interactive effects are kept to a minimum. Furthermore, rather than develop a separate interactive energy model, it is instead recommended that ACPs widen the measurement boundary so that the interactive effects can be incorporated within the baseline and operating energy models. This, however, needs to be balanced against the size of the energy savings compared to the energy consumption within the measurement boundary.

An alternative to simply widening the measurement boundary may be to install additional sub-metering on relevant equipment, which may enable ACPs to isolate and eliminate the interactive effects from the measured data when determining energy savings.

Further information on how to address interactive effects can be found in Section 4.1.4 of the OEH *Measurement and Verification Operational Guide – Best practice M&V processes*.[74]

D.4.3 Accuracy factor

The purpose of the accuracy factor is to discount the energy savings, and therefore ESC creation, based on the accuracy of the energy models that are used.

The accuracy factor is based on calculating the relative precision associated with the energy savings estimate at 90% confidence level, with Table A23 of the ESS Rule stating the thresholds used to assign an accuracy factor. Once the accuracy factor has been determined, it is used to adjust the normal year or measured annual energy savings.[75]

The PIAM&V Tool developed by OEH can be used to assist development of an accuracy factor.[76]

D.4.4 Decay factor and persistence model

Method Guide – section 3.7

"The calculation of energy savings also requires the use of a decay factor, which accounts for the degradation in equipment operation over time.

The decay factor (…) may be influenced by the measurement boundary, the type of end-user equipment that is the subject of the implementation, as well as the site conditions where the implementation occurs."

74 Available at www.environment.nsw.gov.au/energyefficiencyindustry/confirm-energy-savings.htm

75 *ESS Rule*, equations 7A.1 and 7A.3

76 The tool is available at www.environment.nsw.gov.au/business/piamv-tool.htm

The application of a decay factor is intended to account for a gradual deterioration of any new equipment and estimate the decrease in energy savings in future years when forward creating ESCs. This can either be applied through the default decay factors (as outlined in Table A16 of the ESS Rule), or calculated using a persistence model that has been determined to be acceptable for use by the Scheme Administrator.

The OEH PIAM&V Tool provides a persistence model that may be used to calculate decay factors and estimate the lifetime of the upgrade based on a number of project variables and implementation conditions. The application of a persistence model must be deemed appropriate by an M&V Professional.

D.4.5 Calculated energy savings

To calculate the expected energy savings for a project, ACPs must apply the results of the various energy models (or measurements) to the relevant equations as specified in the ESS Rule. Where applicable, it is important that the ACP recognises any previously counted ESCs arising from this or other projects.[77] An example of how counted energy savings should be applied in the calculation of energy savings is provided in Box D.4.

Box D.4 Counted energy savings example

In this example, a refrigeration upgrade project is implemented at an industrial site. A whole of site measurement boundary has been selected and energy models (for baseline and operating periods) have been developed using total site electricity consumption (using utility meter data)

In this case, ESCs have already been created using a different method (Project Impact Assessment Method) for another project previously implemented at the same site (compressed air upgrade). The baseline measurement period for the refrigeration upgrade ended before the implementation of the compressed air upgrade project. The operating measurement period started after the implementation date of both projects. Therefore, energy savings achieved under the compressed air upgrade project (calculated using the PIAM calculation method) must be subtracted from the energy savings calculation using PIAM&V to avoid double counting.

According to the definition provided in Equations 7A.1 and 7A.3, counted energy savings is the total electricity (or gas) savings for which ESCs have previously been created for the implementation.

No interaction between counted energy savings and effective range:

As shown previously in Box D.3, the effective range can limit the normal year energy savings calculated using Equations 7A.2 or 7A.5, ie, the calculation excludes periods for which values fall outside the effective range. This is the only calculation that is affected by the effective range. All other inputs to Equations 7A.1 and 7A.4, including counted energy savings, are not affected by the effective range. For example, counted energy savings must not be adjusted based on effective range, even if there is a discrepancy in

77 *ESS Rule*, equations 7A.1 and 7A.3

the time periods considered for both.

As described previously in section D.1, there are three options to calculate energy savings using the PIAM&V method:

- option (a) allows you to forward create up to 10 years for a single site model with no requirement for future ESC creation
- option (b) allows you to create annually, or if you have previously used option (a), it allows the ACP to top-up on an annual basis, and
- option (c) allows you to forward create up to 10 years for a multiple site model with no provision for future ESC creation.

The specific equations relevant to each option can be found under clause 7A of the ESS Rule.

D.5 Suggested independent variables and site constants

Note that for all technology types, some of the parameters that are suggested as independent variables could also be classed as site constants. This is especially true where the parameter may significantly influence energy consumption, but does not change significantly over the course of a measured period.

One example of this is operating hours. In a commercial building, operating hours is likely to be considered as a site constant (eg, 8am to 6pm, Monday to Friday), but may vary more on a daily basis in other circumstances such as conference facilities or an industrial production site. Parameters such as operating hours can be included as an independent variable by introducing them as a discrete variable, for example with the value of 1 if operating, and 0 if not operating.

The suggested parameters set out below should not be treated as an exhaustive list. There may be additional parameters that require consideration in the context of a particular RESA.[78]

D.5.1 Boilers, steam and compressed air applications

The following parameters provide an overview of the most common parameters that should be used by ACPs to measure and verify energy savings from boiler, steam and compressed air upgrade or replacement projects.

78 Section 6 of the *M&V Guidelines: Measurement and Verification for Performance-Based Contracts*, developed for the US Department of Energy, provides further guidance on how to develop M&V plans for various types of technologies.
Available at energy.gov/sites/prod/files/2016/01/f28/mv_guide_4_0.pdf.

Table D.3 Suggested parameters for boiler, steam and compressed air applications

Energy consumption measurement	Energy consumption before and after implementation will need to be measured to establish both the baseline and operating energy models. The following elements should be measured: ▼ electricity consumption, measured using either utility or sub-meters ▼ gas consumption using either utility or sub-meters ▼ energy content and conversion factors where fuel is metered via volumetric and mass flow measurement (eg, m^3/hr or tonnes/hr)
Common independent variables	Some of the common independent variables that should be considered when developing an energy model for boiler, steam and compressed air applications are: ▼ production, at either a total site level or individual product line. For example, tonnes or number of units. ▼ operating hours – total boiler or compressor operating hours, though this may be impacted by the measurement boundary ▼ compressor delivered air, which can be measured in L/s or m^3/min
Common site constants	Some of the common site constants that should be considered are: ▼ system design, which could include factors such as system type, design and the number of boilers/compressors ▼ efficiency, which would relate to the efficiency of individual pieces of equipment or the system in its entirety ▼ control set points for pressure and temperature of air or steam ▼ steam blowdown rates
Possible interactive effects	There are no common interactive effects from projects for boiler, steam and compressed air applications. Projects will need to be assessed on a case-by-case basis to determine whether interactive effects exist.
Common measurement boundary considerations when developing energy model	The measurement boundary will generally include the boiler or compressor and any supplying pipe network, as well as the EUE. This would need to also include aspects such as air and water inputs to boilers. If interactive effects with other thermal systems are determined on a project specific basis, the measurement boundary should be broadened to take these into account.

D.5.2 Commercial and industrial refrigeration applications

The following parameters provide an overview of the most common parameters that should be used by ACPs to measure and verify energy savings from refrigeration upgrade or replacement projects.

Table D.4 Suggested parameters for commercial and industrial refrigeration applications

Energy consumption measurement	Energy consumption before and after implementation will need to be measured to establish both the baseline and operating energy models. Electricity consumption should be measured using either utility or sub-meters.
Common independent variables	Some of the common independent variables that should be considered when developing an energy model for commercial and industrial refrigeration applications are: ▼ HDDs and CDDs ▼ ambient temperature ▼ relative humidity ▼ production, which could be measured in terms of the throughput of refrigerated content, measured in tonnes ▼ operating hours
Common site constants	Some of the common site constants that should be considered are: ▼ space temperature set points, as applicable to both ambient temperature and relative humidity ▼ system design, including the type, design and number of cabinets ▼ size of the system, which could be measured in terms of total display/floor area (m^2) or volume of refrigerated space (m^3) ▼ seasonality of usage if related to certain production cycles (eg, agricultural produce) ▼ Efficiency, related to the efficiency[79] of individual pieces of equipment and would be measured through either: - Coefficient of Performance (**COP**) - Energy Efficiency Ratio (**EER**), or - Integrated Part Load Value (**IPLV**).

79 Note that for new end-user equipment baseline efficiencies may be published by the Scheme Administrator in accordance with clause 5.3B of the ESS Rule.

Possible interactive effects	The possibility of any interactive effects in commercial and industrial refrigeration is largely dependent on the type of refrigeration installed. For example, in some commercial retail spaces, refrigerated display cabinets can often have spill over of chilled air providing additional cooling to the internal space which can lead to either additional heating or reduced cooling requirements from the HVAC system.
Common measurement boundary considerations when developing the energy model	Measurement boundaries for refrigeration upgrades are generally drawn around an individual piece of equipment, but can also be expanded to include larger segments of a facility such as the full refrigerated space and all associated equipment, through to placing the boundary at the site level where refrigeration represents a significant amount of site energy consumption (eg, cold storage facilities). The applicable measurement boundary will generally be linked to the available metering.

D.5.3 Commercial heating, ventilation and cooling applications

The following parameters provide an overview of the most common parameters that should be used by ACPs to measure and verify energy savings from HVAC upgrade or replacement projects.

Table D.5 Suggested parameters for commercial heating, ventilation and cooling applications

Energy consumption measurement	Energy consumption before and after implementation will need to be measured to establish both the baseline and operating energy models. Electricity consumption should be measured using either utility or sub-meters.
Common independent variables	Some of the common independent variables that should be considered when developing an energy model for commercial heating, ventilation and cooling applications are: ▼ HDDs and CDDs ▼ ambient temperature ▼ relative humidity ▼ operating hours, including times of reduced usage such as weekends, public holidays and seasonality ▼ site occupancy including standard number of people occupying the space included within the project boundary

Common site constants	Some of the common site constants that should also be considered are: ▼ temperature set points, as they apply to both temperature and relative humidity ▼ total floor area (m^2) serviced ▼ IT and lighting loads ▼ control configuration (eg, use of economy cycle) ▼ thermal load, which could be used as both an independent variable and a site constant as it is directly affected by ambient temperature, humidity and occupancy ▼ efficiency[80] of individual pieces of equipment, which can be measured through either: - COP - EER - IPLV
Possible interactive effects	Interactive effects from HVAC projects are not common. There may be minor interactive effects where absorption chillers replace standard chiller systems – resulting in reduced electricity consumption but increased gas consumption.
Common measurement boundary considerations when developing the energy model	Measurement boundaries for HVAC projects are generally drawn around the entirety of the HVAC system and conditioned space (ie, the entire building where the HVAC upgrade has occurred) to ensure that changes to site energy consumption (eg, from lighting upgrades or substantial IT upgrades) are taken into account. An alternative approach would be to draw the measurement boundary around the cooling component of the HVAC system only – with cooling outputs established as the relevant independent variable. Smaller measurement boundaries can have the benefit of creating a larger effective range for the project.

D.5.4 Lighting applications

The following parameters provide an overview of the most common parameters that should be used by ACPs to measure and verify energy savings from commercial lighting upgrade projects.

80 Note that for new end-user equipment baseline efficiencies may be published by the Scheme Administrator in accordance with clause 5.3B of the ESS Rule.

Table D.6 Suggested parameters for lighting applications

Energy consumption measurement	Energy consumption before and after implementation will need to be measured to establish both the baseline and operating energy models. Electricity consumption should be measured using either utility or sub-meters.
Common independent variables	Some of the common independent variables which should be considered when developing an energy model for lighting applications are: ▼ operating hours including times of reduced usage such as weekends and public holidays ▼ daylight hours, in the event that daylight sensors are installed
Common site constants	Some of the common site constants which should also be considered are: ▼ type of lamps ▼ number of lamps ▼ lighting control system ▼ driver type[81] ▼ air-conditioned or non-air-conditioned space
Possible interactive effects	There is a possibility of interactive effects when developing lighting savings projects. Changes to lighting within the measurement boundary may have positive or negative impacts on the total energy consumption of a building's HVAC system.
Common measurement boundary considerations when developing the energy model	All circuits with affected lamps should be captured within the measurement boundary. Measurement boundaries are typically drawn around a lighting circuit, but can be drawn around a larger space, in which case it should capture all affected lighting circuits. Consider including an assessment of the HVAC system or expanding the measurement boundary to the whole of building to ensure all interactive effects can be addressed.

81 Refer to the OEH Energy Efficiency Lighting Technology Report for an overview of the different driver types. Available at www.environment.nsw.gov.au/resources/business/140017-energy-efficient-lighting-tech-rpt.pdf

D.5.5 Motor, pump and fan applications

The following parameters provide an overview of the most common parameters that should be used by ACPs to measure and verify energy savings from motor, pump and fan upgrade projects.

Table D.7 Suggested parameters for motor, pumps and fan applications

Energy consumption measurement	Energy consumption before and after implementation will need to be measured to establish both the baseline and operating energy models. Electricity consumption should be measured using either utility or sub-meters.
Common independent variables	Some of the common independent variables that should be considered when developing an energy model for motor, pump and fan applications are: ▼ production, at either a total site level or individual product line, eg, tonnes or number of units. ▼ process flow rate and demand ▼ operating temperature ▼ operating pressure ▼ operating hours, including periods of reduced usage and the impacts of seasonality ▼ emissions levels, related to situations where system set-points are based on the air composition, eg, carbon monoxide levels in carparks and tunnels ▼ motor utilisation, applicable systems with variable flow and load processes
Common site constants	Some of the common site constants that should also be considered are: ▼ medium that is pumped ▼ impeller size ▼ pipeline and pumping system design / configuration ▼ load factor based on the efficiency and utilisation of the motor and/or fan and pumping system
Possible interactive effects	There is a possibility of interactive effects if the pump or fan motor is part of a larger system which is being changed.
Common measurement boundary considerations when developing the energy model	Measurement boundaries for pumps, motors and fan systems will generally be drawn around the individual pump, motor or fan system. Where the system upgrade affects part of a larger system, resulting in interactive effects, the measurement boundary should be drawn around the broader system to capture these effects.

D.5.6 Fuel switching applications

Following is an overview of the most common parameters that should be used by ACPs to measure and verify energy savings from fuel switching projects such as cogeneration or trigeneration.

Fuel switching projects are not a RESA where the project is eligible to create tradeable certificates under the *Renewable Energy (Electricity) Act 2000* (Cth) or leads to a net increase in greenhouse gas emissions.[82] Cogeneration projects are not RESAs where the generated electricity is exported to the electricity network or the cogeneration system has nameplate rating of 5MW or higher.[83]

Cogeneration parameters have been included to provide ACPs with guidance on how to calculate appropriate electricity and gas consumption, to net out amounts for applicable projects.

Table D.8 Suggested parameters for cogeneration applications

Energy consumption measurement	Energy consumption before and after implementation will need to be measured to establish both the baseline and operating energy models. The following elements should be measured: ▼ input energy – broken down into electricity and gas where applicable ▼ total electricity generation – electricity consumed on-site and electricity exported ▼ thermal heat recovered
Common independent variables	Some of the common independent variables that should be considered when developing an energy model for cogeneration applications are: ▼ power produced from the system, generally measured in megawatts (MW) ▼ heat, in terms of the quantity of heat recovered from the system, generally measured in gigajoules (GJ) ▼ type of fuel used to power the system (eg, natural gas) ▼ operating hours, including times of reduced usage such as weekends and public holidays, as well as seasonality ▼ system loads/activity levels ▼ input raw materials ▼ production types and amounts

82 *ESS Rule*, cl 5.4(g) and 5.4(j)
83 *ESS Rule,* cl 5.4(i)

Common site constants	Some of the common site constants that should also be considered are: ▼ total installed capacity of the system ▼ conversion efficiency ▼ system downtime, which would refer to average shutdown hours based on both planned and unplanned maintenance as well as system availability ▼ system design, related to the system type, sizing and utilisation factor for any cogeneration system. As well as the design of any inherent pumping system
Possible interactive effects	Any interactive effects would be largely dependent on the type of technology installed, and whether the cogeneration/ trigeneration system interacts with any other thermal systems on site.
Common measurement boundary considerations when developing the energy model	Measurement boundaries will generally be drawn around an individual piece of installed equipment. Boundaries can be expanded to include larger segments of the facility where there is an interactive effect between the cogeneration system and other thermal systems (such as heat recovery).

D.5.7 Whole building application

The following parameters provide an overview of the most common parameters that should be used by ACPs to measure and verify energy savings where upgrade projects cover a range of activities and impact on the total energy consumption of a particular site.

Table D.9 Suggested parameters for whole of building applications

Energy measurement consideration	Energy consumption before and after implementation will need to be measured to establish both the baseline and operating energy models. The total site energy consumption should be measured (both gas and electricity).

Common independent variables	Some of the common independent variables that should be considered when developing an energy model for whole building applications are: ▼ ambient temperature ▼ relative humidity ▼ operating hours, including times of reduced usage such as weekends and public holidays, as well as seasonality where applicable. ▼ occupancy, using units relevant to the applicable service area (for instance a hospital might use hospital bed days or number of hospital beds, event centres might use special event occupancy, and commercial building occupancy might be based on Full Time Employees (**FTEs**))
Common site constants	Some of the common site constants that should also be considered are: ▼ temperature system set points and how they react to both temperature and relative humidity set points ▼ total serviced floor area (m^2) ▼ changes to system control logic
Possible interactive effects	The inherently broad measurement boundary will include interactive effects, so these will not have to be accounted for.
Common measurement boundary considerations when developing the energy model	The measurement boundary would be drawn around the entire building in this instance so that all energy flows can be measured from the primary utility meter(s).

E Worked example – Measurement & Verification Plan

Contact details

ACP contact details

Name	John Smith
Corporation name	Major Sydney Hospital
ABN	11111111111
Postal address	100 George Street, Sydney, 2000
Phone number	(02) 1111 1111

Individual site details

Corporation name	ABN	Site address	Contact name	Phone number
Major Sydney Hospital	12121212121	100 George Street, Sydney, 2000	Jane Smith	(02) 8888 8888

M&V Professional details

Name	Paul Jones
Corporation name	M&V Professionals Pty Ltd
ABN	99999999999
Postal address	100 Miller Street, North Sydney, 2060
Phone number	(02) 9999 9999

Measurement & Verification Design

This is a sample M&V planning format only. ACPs are not restricted to using this format and may develop their M&V plans using different templates.

Table E.1 Site details

Example Project Input

Site details	The site is a hospital in Sydney. The building is 38 years old and has a capacity of 2,000 beds. The hospital is in operation 24 hours per day with a range of adminsitrative staff that work Monday to Friday 7am to 5pm.
Total energy summary	Provide a summary of energy consumption for the site(s).

Site	Energy Source	Consumption	Unit	Period
Major Sydney Hospital	Electricity	2,705,278	kWh	1/01/2012 – 31/12/2012
	Natural Gas	3,637	GJ	1/01/2012 – 31/12/2012
	Diesel	20,000	Litres	1/01/2012 – 31/12/2012

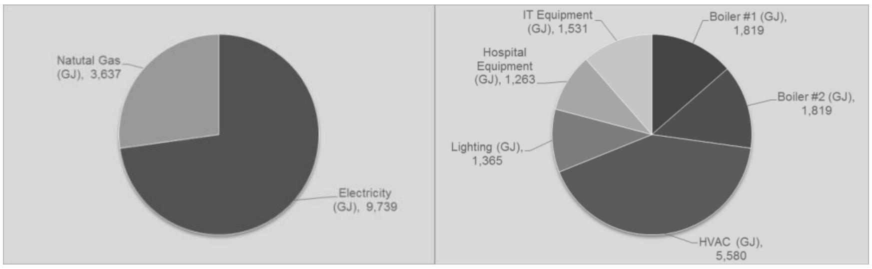
Meter Details	Provide a summary of existing available meters, and sub-meters on site.

Site	Meter Identifier	Description
Major Sydney Hospital	NMI: NCCC123456	Electricity Utility Meter
	EM_S2_CH1 (kWh)	Chiller 1
	EM_S2_CH2 (kWh)	Chiller 2
	EM_S2_CH3 (kWh	Chiller 3
	EM_S2_CH4 (kWh)	Chiller 4
	EM_S2_CH5 (kWh	Chiller 5
	EM_S2_CH6 (kWh)	Chiller 6
	EM_S2_CH7 (kWh)	Chiller 7
	EM_S2_CH8 (kWh	Chiller 8
	EM_S2_CTE (kWh)	House Lighting
	EM_S2_CTE (kWh)	Ancillary equipment including cooling tower, chilled water pumps, condenser water pumps and control systems
	DPI: 12345678901	Natural gas utility meter

Fuel source breakup

Provide a chart indicating the breakup of both fuel source and functional area consumption for each site. The purpose of this is to enable a broader understanding of how total energy is consumed on site, and can be used as supporting evidence to justify the selection of the project boundary or help estimating the impact of interactive effects.

Major Sydney Hospital – Energy breakup



Energy consumption trends

Provide a chart indicating the monthly trend of fuel source consumption for each site. The purpose of this is to identify any cyclical patterns in consumption that may need to be understood for M&V inputs.

Major Sydney Hospital – Monthly energy consumption

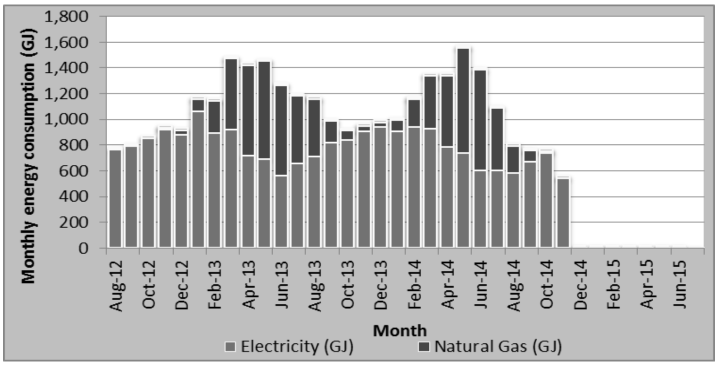


Table E.2 Project details

Example Project Input

Project description

The hospital is planning to upgrade its air conditioning plant. Equipment that will be replaced includes:

- upgrade of 2 x existing chillers (installed in 1978 and 1983) to 2 x 4000kW variable speed drive centrifugal chillers
- additional 2 x cooling towers to meet increased capacity and provide improved condenser water temperature control
- new condenser water and chilled water pumps with variable speed drives, and
- new integrated control system with automatic system optimisation.

This upgrade will build on other recent upgrades including fitting variable speed drives to chilled water and condenser water pumps.

As the intention is to measure all variables relating to energy consumption by the chillers pre and post retrofit, this M&V activity aligns itself with an Option B (IPMVP) methodology to determine energy savings.

	Available metering	Existing metering linked with the current Building Management System (BMS) is able to provide consumption data for individual chillers. This level of coverage is sufficient to meet M&V requirements.

Table E.3 Independent variables and site constants

Example Project Input

Measurement boundary

The measurement boundary is defined as being the electricity input supply to the air conditioning system measured by the data points within the BMS system and defined in the energy consumption area below.

Energy consumption

Identify and define how energy consumption will be calculated based on meter data. This data can be copied from the OEH PIAM&V Tool.

Meter identifier/name	Description	How measured/calculated
EM_S2_CH2 (kWh)	Chiller 2	Through BMS
EM_S2_CH4 (kWh)	Chiller 4	Through BMS
EM_S2_CH6 (kWh)	Chiller 6	Through BMS
EM_S2_CH7 (kWh)	Chiller 7	Through BMS
EM_S2_CTE (kWh)	Ancillary equipment including cooling tower, chilled water pumps, condenser water pumps and control systems	Through BMS

Independent variables

Independent variables refer to regularly changing parameters affecting a site's energy consumption. This data can be copied from the OEH PIAM&V Tool.

Independent variable name	Units	Description
Daily air temperature	°C	Average air temperature. Used to calculate CDD and HDD
Working days	TRUE / FALSE, or 1 / 0	Binary value to describe if a day is a working day (Monday to Friday) or non- working day (Saturday, Sunday and public holidays)

Example Project Input (cont)

Site Constants

Site constants refer to less regular changes or events that may affect a site's energy consumption. This data can be copied from the OEH PIAM&V Tool.

Site constant name	Units	Description
Chiller #1 operational	on/off	Chiller is operational and not offline as part of commissioning / maintenance
Chiller #2 operational	on/off	Chiller is operational and not offline as part of commissioning / maintenance
Hospital operating hours	Hours	Standard operating hours for day patients and administrative staff

Excluded variables

Excluded variables refer to independent variables or site constants for which data is available, but are either dependent on the other variables or don't have a strong influence on energy consumption.

Excluded variable name	How measured/calculated	Reason excluded from model
Floor area	Site plans/drawings	Floor area has remained constant during the baseline period and there are no plans for future expansions or reduction of hospital areas for the life of the project. As such, this site constant has been excluded from the model.
Patient beds	Can be retrieved from hospital records	Regression analysis shows a poor correlation between the number of patient beds and the energy consumption. The t-statistic value obtained is lower than 2. The number of patient beds is not expected to vary significantly in the future and it is therefore excluded from the model.
Relative humidity	Measured from local weather station	Regression analysis shows a poor correlation between relative humidity and the energy consumption. The t-statistic value obtained is lower than 2. High humidity levels can increase HVAC energy consumption, but in this case, the effect of humidity did not increase the predictive power of the model. Temperature was generally found to be correlated with humidity, so the inclusion of temperature in the model already indirectly included the effect of humidity.

Data sources

Variable name	How measured/ calculated	Accuracy Type	Margin of error
Daily air temperature	Measured from local weather station (BOM[84] station no. 66124). Average of Daily minimum and maximum recorded values	Absolute error	±0.05°C
Working days	Set to TRUE (1) for all days Monday to Friday, except public holidays	Absolute error	± 0
Chiller #1 operational	Maintenance records	Absolute error	± 0
Chiller #2 operational	Maintenance records	Absolute error	± 0
Hospital operating hours	Hospital records	Absolute error	± 0

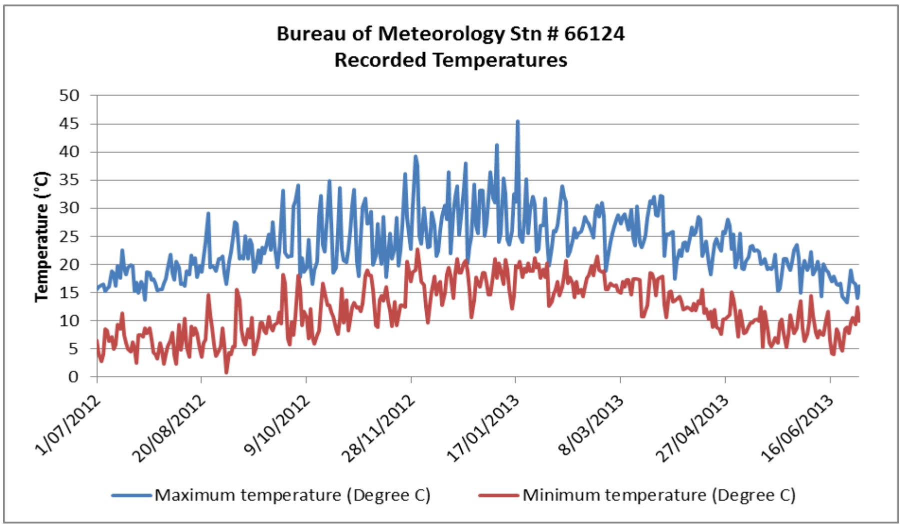
[84] BOM: Bureau of Meteorology

Table E.4 Normal year

Example Project Input		
	Definition	The 12 months of collected data used to inform the development of the baseline energy model has been selected as the definition of the normal year.
	Justification	Defining the normal year to be an actual period of 12 months of performance data ensures that a full operating cycle is captured for the independent variables. In this case, it includes the full seasonality associated with daily ambient air temperature across the year and the full amount of normal working days in a year associated with the hospital.

Table E.5 Effective range

<table>
<tr><th>Example Project Input</th><th></th><th></th></tr>
<tr><td></td><td>How has this been defined?</td><td>For daily air temperature (variable #1), minimum and maximum values from BOM station number 66124 are obtained. Daily air temperature is then defined as being the average of the minimum and maximum. Data is reproduced in the figure below.



For working day (variable #2), this is determined as a Boolean either TRUE or FALSE based on hospital operation as follows:

- TRUE: Monday to Friday where the hospital is in full operation
- FALSE: Saturday, Sunday and Public Holidays where the hospital is partly operating</td></tr>
</table>

Table E.6 Baseline energy model

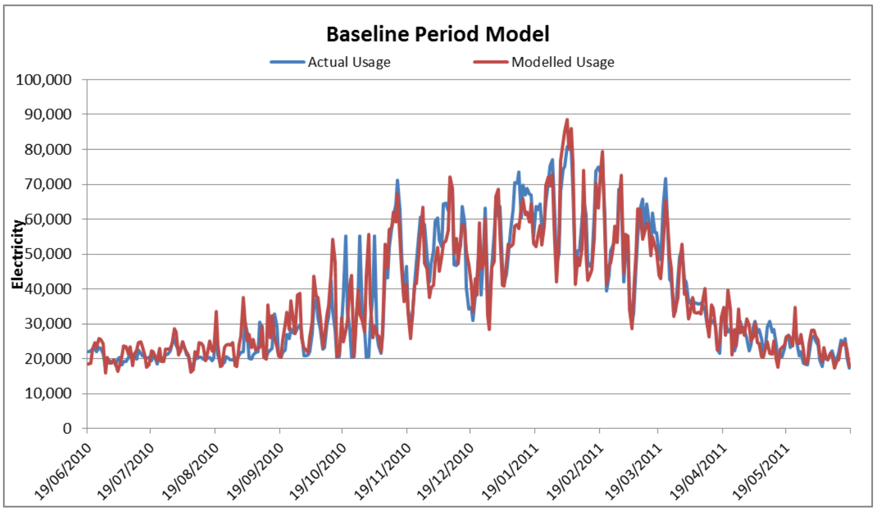
Example Project Input

Regression equation

A regression analysis was completed using a relevant software package

Baseline energy model

Present a chart of the baseline energy model showing the predicted consumption against actuals. This could be in the form of an XY plot where only one variable exists, or as energy consumption over time for one or more variables.



Statistical validity

Is the model statistically a good fit? Note that meeting the following criteria is not a requirement under the ESS Rule, however doing so should provide the ACP with confidence that they have developed an adequate energy model.

Modelling criteria	Recommended values	Baseline energy model value
t-statistic of independent variables	>2	CDD t-stat = 39.7 HDD t-stat = 10.0 Working day t-stat = 6.4
Lesser R^2 or adjusted R^2	> 0.75	0.87682
Relative precision calculated at 90% confidence level	Within ±200% (refer table A23 of ESS Rule)	29.1%
Non-routine events removed	<20% of the measurement period	0%

Justification

The energy model is representative of a standard commercial building within the Sydney built environment with a strong relationship with weather, together with a higher energy usage occurring on standard working days compared to weekends.

Table E.7 Operating energy model[85]

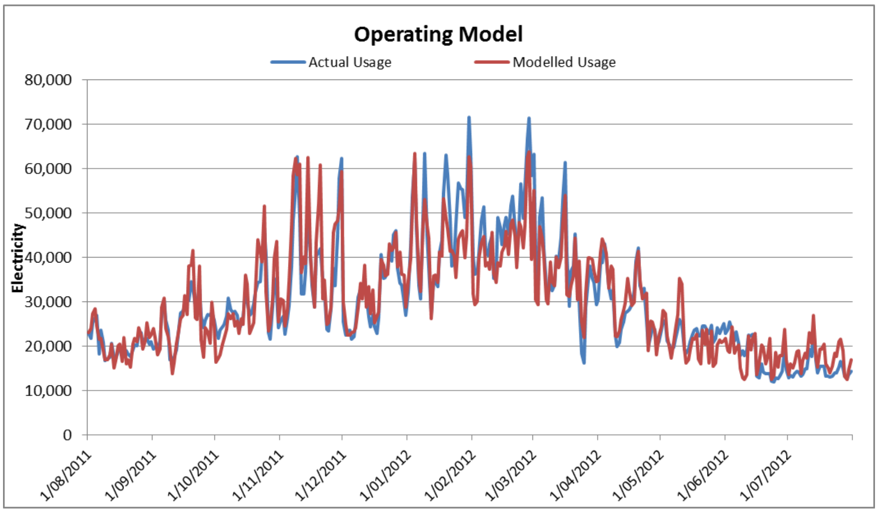
Example Project Input

Regression equation

A regression analysis was completed using a relevant software package

Operating energy model

Present a chart of the operating energy model showing the predicted consumption against actuals. This could be in the form of an XY plot where only one variable exists, or as energy consumption over time for one or more variables.



Statistical validity

Is the model statistically a good fit? Note that meeting the following criteria is not a requirement under the ESS Rule, however doing so should provide the ACP with confidence that they have developed an adequate energy model.

Modelling criteria	Recommended values	Operating energy model value
t-statistic of independent variables	>2	CDD t-stat = 29.9 HDD t-stat = 9.1 Working day t-stat = 7.2
Lesser R^2 or adjusted R^2	> 0.75	0.86322
Relative precision calculated at 90% confidence level	Within ±200% (refer table A23 of ESS Rule)	27.2%
Non-routine events removed	<20% of the measurement period	0%

Justification

The energy model is representative of a standard commercial building within the Sydney built environment with a strong relationship with weather, together with a higher energy consumption occurring on standard working days compared to weekends.

85 Note: this is only required for the forward creation of ESCs. If creating annually or topping-up ESCs, please skip this section and continue straight to 'Interactive energy savings'.

Table E.8 Interactive energy savings

Example Project Input	**Have any interactive energy savings been considered within the measurement boundary?**	None were identified for this example
	Justification	N/A

Table E.9 Accuracy factor

Example Project Input	**Has an accuracy factor been applied to any estimated savings?**	Based on the relative precision for both the baseline and operating energy models being between 25-50%, the accuracy factor should be 0.9.
	Justification	Use of accuracy factor drawn from Table A23 of the ESS Rule. Plan will be to use the OEH PIAM&V Tool so that the accuracy factor is automatically selected.

Table E.10 Persistence model / Decay factor

<table>
<tr><td rowspan="2">Example Project Input</td><td>How has a decay factor been applied to any estimated savings?</td><td>
<table>
<tr><th>Expected lifetime/year</th><th>Decay Factor</th></tr>
<tr><td>1</td><td>1</td></tr>
<tr><td>2</td><td>0.8</td></tr>
<tr><td>3</td><td>0.64</td></tr>
<tr><td>4</td><td>0.51</td></tr>
<tr><td>5</td><td>0.41</td></tr>
<tr><td>6</td><td>0.33</td></tr>
<tr><td>7</td><td>0.26</td></tr>
<tr><td>8</td><td>0.21</td></tr>
<tr><td>9</td><td>0.17</td></tr>
<tr><td>10</td><td>0.13</td></tr>
</table>
</td></tr>
<tr><td>Justification</td><td>This has been drawn from the default values in Table A16 of the ESS Rule.</td></tr>
</table>

Table E.11 Calculated energy savings

Example Project Input	**Please provide details of any previous energy savings**	Nil – This is a new project and will be forward creating ESCs for anticipated energy savings for up to 10 years.
	Which equations will be used to calculate energy savings?	This project involves the forward creation of ESCs using the normal year approach. As such, Equations 7A.1 and 7A.2 of the ESS Rule will be used to determine the energy savings over the 10 year period. Additional energy savings may be claimed in the future using the annual top-up approach (starting in Year 1).