Energy Efficiency Obligations Scheme

Guidance on authenticating and claiming energy credits

Version 1.0

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GLOSSARY OF TERMS

Energy Credits – Every kWh of primary energy saved is an energy credit.

Energy Efficiency – The ratio between an output of performance, service, goods or energy and an input of energy (Directive 2012/27/EU).

Energy Efficiency Improvement – An increase in energy efficiency as a result of technological, behavioural and/or economic changes (Directive 2012/27/EU).

Energy Efficiency Improvement Measure – Any action, including provision of information that leads to verifiable and measurable or estimable energy efficiency improvements (EEOS Guidance). This term is interchangeable with EPIA (ISO50015) and ECM (IPMVP).

Energy Efficiency Obligation Scheme (EEOS) - This is administered by the SEAI and Obligated Parties are bound to deliver energy savings to match their allocated targets. This is driven by Article 7 of the Energy Efficiency Directive (2012).

Host Organisation – An organisation which is implementing and benefiting from an Energy Efficiency improvement or process.

Final Energy – The energy used by equipment, i.e. metered energy.

Non Residential Energy Credits (NREC) Form – For an OP to claim energy credits from the SEAI they must fill out an NREC application form.

Obligated Party (OP) – Energy Distributer or retail energy sales company that has market sales in Ireland of greater than 600GWh per annum.

Preliminary M&V Report – In circumstances where the OP wants to claim the energy credits from an Energy Efficiency Improvement Measure before the Reporting Period has ended, a Preliminary M&V Report must be completed. This will analyse the available performance data from the Reporting Period to date, and project an annual energy savings figure. The results of the analysis are then submitted in the NREC form as part of the Synopsis M&V Plan and Preliminary M&V Report.

Primary Energy – A measure of the energy used by a facility which takes into account all transformation and distribution losses. Each form of final energy is converted to primary energy by using a conversion factor which is supplied in the NREC form.

Final M&V Report – The Final M&V Report must be drafted after the Reporting Period has ended. It will analyse all of the performance data and make any routine and non-routine adjustments to establish an annual energy savings figure. This Final M&V Report must be completed, even if a Preliminary M&V Report has already been completed.

Synopsis M&V Plan and Report – In order for the OP to claim energy credits a Synopsis M&V Plan and Report must be submitted as an attachment to an NREC application. This summarises the M&V Plan methodology and Report findings. It may be based on either a Preliminary or Final M&V Report.

Sub-projects – In an NREC application there may be 1 or several sub-projects which are being grouped together. The sub-projects may be located within the same client site, or they may be many similar projects spread across various sites.

Acronyms

AHU	Air Handling Unit
ASRAE	American Society of Heating, Refrigeration and Air-Conditioning Engineers
CEM	Certified Energy Manager (The Association of Energy Engineers - aee)
CER	Commission for Energy Regulation
CIBSE	Chartered Institute of Building Services Engineers
CHP	Combined Heat and Power
CMVP	Certified Measurement and Verification Professional (aee)
CV	Calorific Value (Gross – GCV, or Net – NCV see Appendix B for further clarifications)
ECMS	Energy Credit Management System
EEOS	Energy Efficiency Obligation Scheme
EEIM	Energy Efficiency Improvement Measure
EnB(s)	Energy Baseline(s)
EnPI	Energy Performance Indicator
EVO	Efficiency Valuation Organisation
IPMVP	International Performance Measurement and Verification Protocol
M&V	Measurement and Verification
NREC	Non Residential Energy Credit
OP	Obligated Party
PEP	Project Evaluation Platform
SEU	Significant Energy User
TUFA	Total Utilised Floor Area
VSD	Variable Speed Drive

1. Introduction

1.1 Overview

This document provides guidance on SEAI requirements for authenticating and claiming energy saving credits associated with energy efficiency projects under the Energy Efficiency Obligation Scheme (EEOS). It has been prepared for use by the Obligated Parties (OP) and their consultants. A separate EEOS Guidance document informs the OP of their obligations in relation to the scheme; the Scheme has been developed pursuant to Article 7 of the Energy Efficiency Directive.

Briefly, in order for an OP to claim energy saving credits, the OP must identify and document a suitable means to authenticate the energy savings associated with an Energy Efficiency Improvement Measure (EEIM), and submit a claim for the energy saving credits (Non-Residential Energy Credit form, or 'NREC form') along with some supplementary information to SEAI.

The primary method for authenticating energy savings is the preparation of a Measurement and Verification (M&V) Plan and, subsequently, an M&V Report of savings achieved. Internationally accepted frameworks to measurement and verification of energy savings exist, such as the standard ISO50015 or the International Performance Measurement and Verification Protocol; it is not SEAI's objective to either undermine or replace these in any way.

In order to reduce the overall M&V burden on OP, SEAI has identified some derogations that permit, in certain circumstances, the use of Engineering Calculations as an alternative to M&V.

This guidance:

- Explains the process for claiming energy credits, and identifies associated documentation requirements.
- Identifies the derogation criteria that permit the use of Engineering Calculations and explains how to establish whether Engineering Calculations or M&V will be used.
- Identifies specific SEAI requirements for the M&V Plan and M&V Report. The terms 'must' or 'require' are generally used to identify such requirements.
- Identifies areas where the OP may adopt alternative approaches to reduce the M&V burden. M&V Plans and Reports must follow well established methodologies such as IPMVP or ISO50015, but do not have to be fully compliant to satisfy EEOS requirements. This document provides guidance on where areas of latitude are allowable by the SEAI. The terms 'may' or 'recommend' are generally used to identify such approaches. The OP is always free to choose to be fully compliant with IPMVP or ISO50015, rather than using SEAI alternatives.
- Identifies requirements for Engineering Calculations, including some worked examples.
- Identifies requirements for evidence that specific energy efficiency projects have been implemented.

1.2 Principles for Quantifying Energy Savings

SEAI requires:

- That the work must be completed by a professionally competent individual, ideally CMVP, CEM, or equivalent. That individual must exercise professional integrity and act in an objective, impartial way.

- Whether using M&V or Engineering Calculations, that results must be accurate, complete, conservative, consistent, relevant and transparent. Accuracy trade-offs must be accompanied by increased conservativeness in any estimates and judgements[1]. A conservative approach must be adopted when making any assumptions or using unsubstantiated data. Where SEAI allows measurement of a particular parameter to be avoided, the outcome must be conservative.
- That all analyses must be transparent to any external auditor and all assumptions made and calculation steps must be clearly displayed.

1.3 SEAI Quality Framework

From SEAI's perspective, Energy Credits are a product supplied by the OP, and the OP provides this product through its own activities and by working with contractors and hosts. Although SEAI maintains oversight of the product, the OP is responsible for their quality and must put in place a quality management system, such as ISO9001, to ensure robust processes are in place for the delivery of a quality product.

SEAI also requires the OPs adopt robust methods for the measurement and verification of energy savings (credits), and for the calculation of energy savings, as appropriate. ISO50015 and the IPMVP provide frameworks for robust measurement and verification. Terminology must be as defined in IPMVP or ISO50015.

Where hosts are improving energy use on a multi-year basis through multiple projects and/or energy management, an energy management system such as ISO50001 provides a robust system for capturing such energy savings. SEAI encourages the adoption of ISO50001 and will allow energy suppliers claim a portion of energy credits up front where ISO50001 is put in place and sustained.

Certified schemes, such as ISO9001 and ISO50001, require the performance of the systems to be measured, analysed and continually improved.

In order to continually verify savings from ongoing EEIMs, SEAI recommends the Host Organisation adopts an energy management programme such as ISO50001. This will provide the Host with the necessary procedures to enable them to monitor, measure and analyse energy use. Further details are provided in Section 3.

1.4 Process

In order for the OP to claim energy credits a defined process, as illustrated in Figure 1.1 (overleaf), must be followed.

Once an energy efficiency improvement measure has been identified, and the OP has agreed on how they will provide a demonstrably material impact, it must be decided how the savings will be quantified.

The most accurate way of establishing the energy savings from an EEIM is to follow well established M&V principles. However SEAI recognise that to conduct full M&V on every EEIM identified by an OP would be cost prohibitive, particularly for smaller projects, and some derogations have been identified for which engineering calculations may be conducted instead.

[1] IPMVP Chapter 3 'Principles of M&V'.

A derogation decision tree has been developed which allows an OP to decide which projects and sub-projects require full M&V and which may use engineering calculations. This decision tree can be seen in section 2 of this document.

Once the savings have been established a Non Residential Energy Credit (NREC) application form can be filled out and submitted to the SEAI to claim the credits.

1.5 Completing an NREC Application

In order to claim energy credits the OP must complete a Non-Residential Energy Credit (NREC) application form. This includes a Synopsis M&V Plan and Report and/or summary information on Engineering Calculations as appropriate.

- The summary information of Engineering Calculations should be submitted in Section 2g of the NREC form.
- The Synopsis M&V Plan and Report should be attached to the NREC form.

Where M&V is being undertaken and the end of the reporting period carries into the next calendar year, and the OP wishes to claim the energy credits within the current annual cycle, the OP may produce a Preliminary M&V Report.

All energy consumption and energy savings must be reported in Final Energy or metered energy; non-electrical energy must be reported in kWh on a Gross Calorific Value basis. See Appendix B for more details. These figures should be added into the appropriate table in section 3a of the NREC form and then converted to Primary Energy using the factors as provided in that table.

Final Energy will be converted to Primary Energy Equivalent in Section 3 of the Non-Residential Energy Credits Form (NREC).

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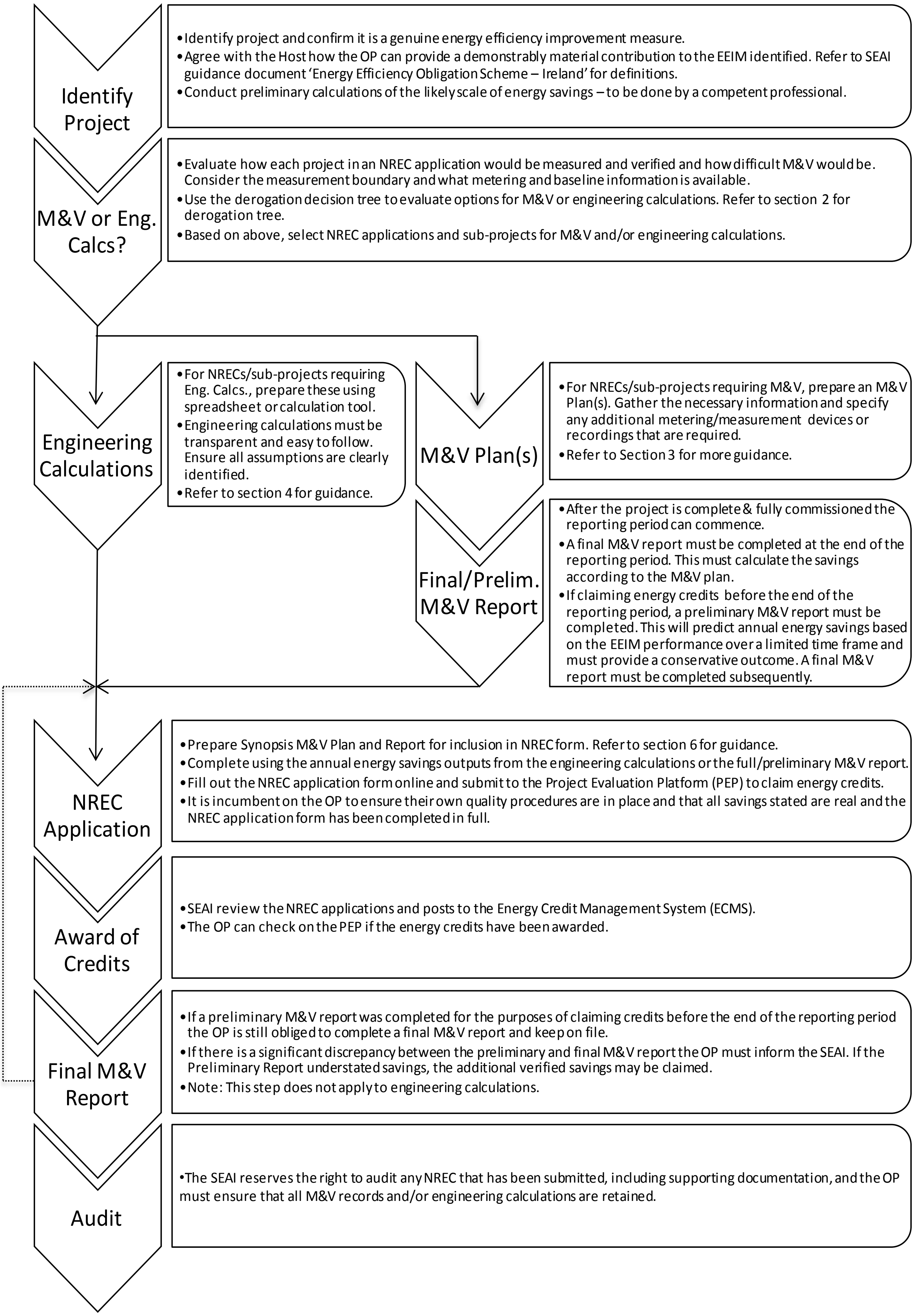
Fig. 1.1 Process for quantifying and claiming energy credits



2. Derogations

2.1 Introduction

The primary method for quantifying energy savings is the preparation of a Measurement and Verification (M&V) Plan and, subsequently, an M&V Report on savings achieved. In order to reduce the overall M&V burden on OPs, SEAI has identified some derogations that permit, in certain circumstances, the use of Engineering Calculations as an alternative to M&V. There are also derogations that permit the use of conservative default values which will reduce the burden in Engineering Calculations or Measurement & Verification. It is at the OP's discretion whether or not to use these.

2.2 Derogation for Projects Employing Specific Well-Proven Technologies

Engineering Calculations may be used instead of M&V where projects or sub-projects (a) employ specific (i.e. listed below) well proven technologies with little operational variance and (b) deliver savings that are less than 20% of the OP's sectoral target.

The specific technologies to which this derogation applies are:

- Lighting upgrade projects where no controls are added.
- Building fabric upgrades.

2.3 Derogation for Smaller Scale NREC Applications and Sub-Projects

For smaller NREC Applications or smaller sub-projects (i.e. where the energy credits are less than 0.5 GWh) SEAI only requires that a sample of these projects or sub-projects be measured and verified.

The Derogation Decision Tree (Figure 2.1) provides a method to determine if a NREC application or associated sub-projects require M&V or if Engineering Calculations may be performed. A worked example is also provided (Figure 2.2)[2].

Note: The derogation tree sets out the <u>minimum</u> amount of NREC applications and sub-projects which shall require full M&V. An OP may wish to M&V more projects than required to provide greater certainty of savings being claimed and to improve their quality systems.

[2] A PDF version of Figures 2.1 and 2.2 are available in A3 size for download from the SEAI website.

Figure 2.1 - Derogation Decision Tree

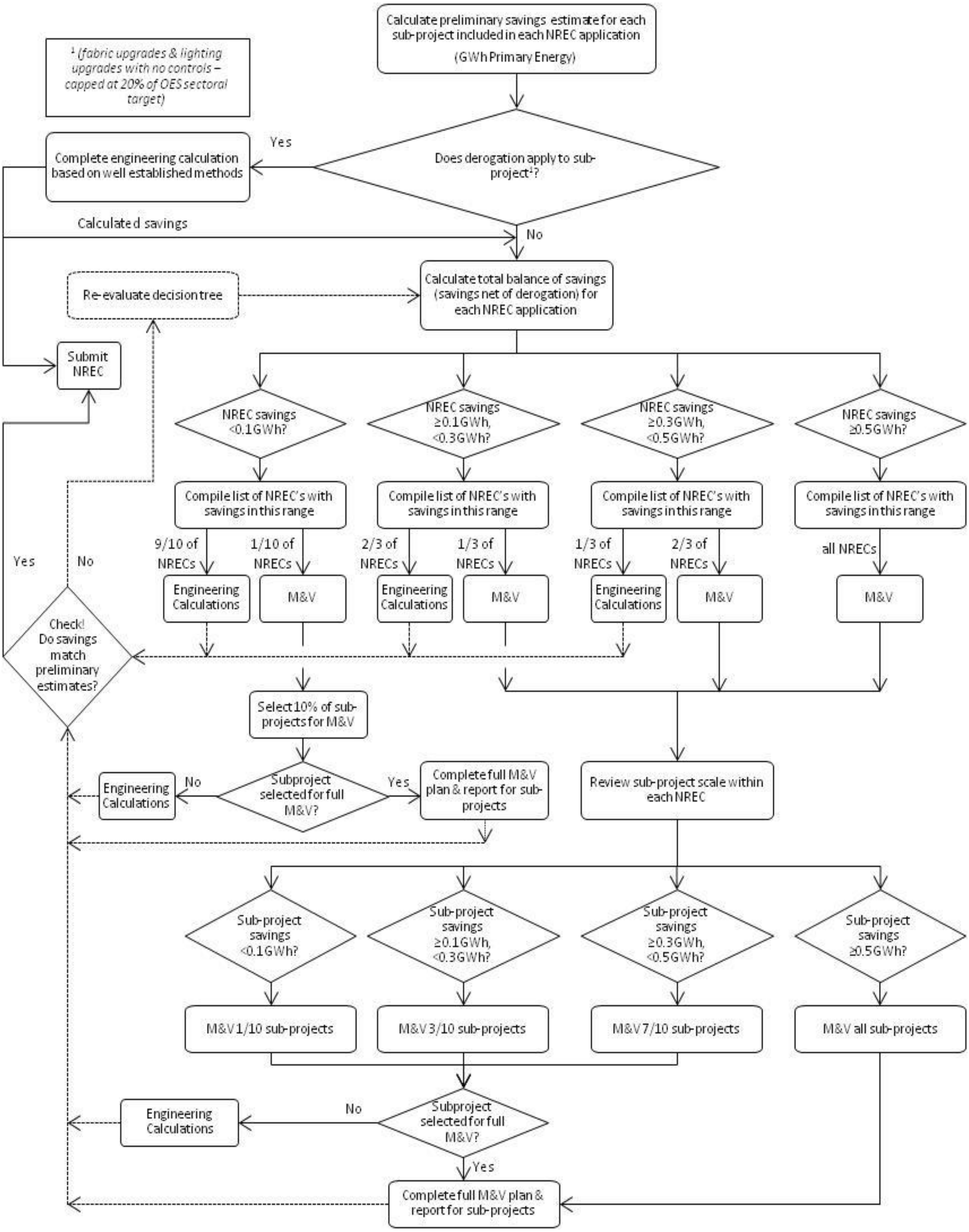
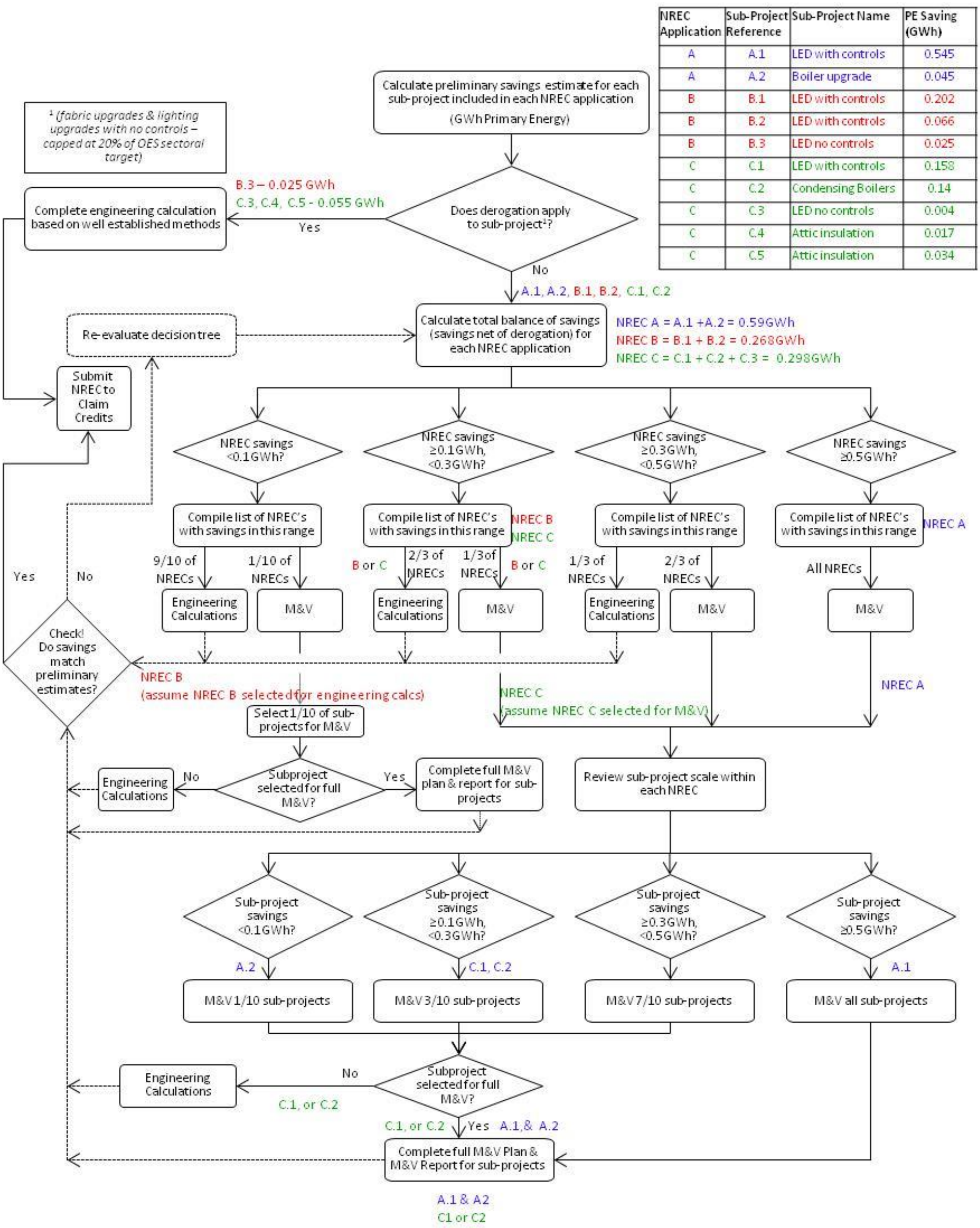


Figure 2.2 - Derogation Decision Tree Worked Example

NREC Application	Sub-Project Reference	Sub-Project Name	PE Saving (GWh)
A	A.1	LED with controls	0.545
A	A.2	Boiler upgrade	0.045
B	B.1	LED with controls	0.202
B	B.2	LED with controls	0.066
B	B.3	LED no controls	0.025
C	C.1	LED with controls	0.158
C	C.2	Condensing Boilers	0.14
C	C.3	LED no controls	0.004
C	C.4	Attic insulation	0.017
C	C.5	Attic insulation	0.034



2.4 Conservative Defaults

There are also derogations that permit the use of conservative default values which will reduce the burden in either Engineering Calculations or Measurement & Verification. These are provided in Table 2.1 below. As the default values are conservative, one may alternatively adopt an evidence-based approach.

Table 2.1 – Conservative Defaults

Technology	Guidance	Default Value	Evidence Approach
Lighting with electromagnetic gear	Where Electro-Magnetic (EM) ballasts are being replaced with electronic, use default or evidence for savings.	Refer to Appendix C for default values.	Measure / data sheet and photo of nameplate.
Building fabric	U-values based on default or evidence.	Regulations at time of construction.	Photo/ proof of purchase, data sheet.
Boiler upgrade	Use boiler rated peak efficiency rather than measured seasonal efficiency where it will result in conservative outcome. Very useful approach when converting heat savings to fossil fuel. Note: it is essential that the original and proposed boiler rated efficiencies are established on a similar basis. Whilst theoretical seasonal efficiencies are provided for new boilers this cannot be used unless the theoretical seasonal efficiency of the original boiler is known. Note: Unless the new boiler will be operating continually at a lower temperature, the rated efficiency of the new boiler must be at the higher temperature (typically 80degC flow, 60degC return).	Boiler rated efficiency.	Measured burner efficiency. Measured seasonal efficiency (heat out / fuel in).
Cooling unit upgrade	Cooling unit rated efficiency where it will result in conservative outcome. Very useful approach when converting cooling savings to electricity.	Cooling unit rated efficiency.	Measured seasonal efficiency (cool out / electricity in).

3. M&V Plan & Report

3.1 Cover Page

The cover or first inside page of the M&V Plan (and M&V Report) must include the following table, duly completed:

EEOS M&V Plan [or Report]	
Project Title	
Energy Supplier Name	
Energy Supplier Contact Name	
Host Organisation Name	
Host Contact Name	
Prepared by	[name and qualifications / competency of person who prepared the M&V Plan/Report]
Signature	I have completed this M&V Plan/Report acting as an impartial professional:
Date	
Status	[e.g. draft, issued for host review, complete]
M&V Standard/Protocol Employed	[e.g. Based on IPMVP or ISO50015]

Whilst it is at the discretion of the OP as to how to structure the M&V Plan, having due consideration to the relevant standard or protocol, the items identified below must be addressed.

3.2 M&V Plan

3.2.1 Energy Efficiency Improvement Measure Intent

Each M&V Plan must include a brief explanation of the Energy Efficiency Improvement Measure (EEIM) and how the EEIM will deliver energy savings in accordance with the EEOS guidelines. It should identify the area/piece of equipment and the scope of work. This should be described in a way that a reader unfamiliar with the site will gain an understanding of the project intent. A well described EEIM including commentary on the energy or demand drivers will assist the reader in determining if the appropriate M&V methodologies have been used to measure EEIM savings.

Essential Requirement:

- A succinct and clearly stated EEIM which explains the resulting energy conservation mechanism.
- Where there are a number of EEIMs, each should be numbered and described separately.

For instance:

"EEIM#1 – Variable speed control of AHU LTHW circuit pump

The AHU LTHW circuit pump (P004) control EEIM will modify the existing method of pump control from fixed speed constant volume operation to variable speed demand based operation. This will be achieved through installation of VSDs, replacement of 3 port valves with 2 port valves at each AHU, and a controlling pressure sensor to determine when flow demand is satisfied. The electricity saving will arise from the reduction of pump power consumption when AHUs are off or have a low heat load. Gas savings will arise from a reduction in return water temperature which will improve boiler operating efficiency."

3.2.2 Selected M&V Approach

The M&V Plan must clearly state the M&V Approach selected, including briefly the logic for this decision. IPMVP terms such as "Option C – Whole Facility" may be used, but a fuller description of how M&V is being approached is also required.

Where 'key parameter measurement'[3] is selected, it must identify the estimated parameter and measured parameter.

Q. If using key parameter measurement, which parameter should I measure?

A. You must measure the parameter that the EEIM will change. For instance, if one is changing light fittings, but not the controls, the key parameter is the change in load (kW); if one is changing lighting controls, but not the fittings, the key parameter is time (h).

Q. What if the expected savings are below 10% of metered use?

A. In order to perform M&V on an EEIM within a facility, the scale of the EEIM's savings must be significant enough to have a discernible impact on energy use recorded by the associated meter. The OP must provide sufficient evidence to demonstrate the saving is beyond normal fluctuations in energy use; this is likely to prove more challenging where the savings are less than 10% of metered use.

In all cases the baseline and reporting periods must be sufficiently long to demonstrate, either by direct comparison or analysis, that there is a clear and persistent trend before and trend after, and that each can be clearly distinguished rather than within the day to day fluctuations of energy use.

Where the percentage change is small, the persistence of these savings may need to be demonstrated over several operating cycles.

If it is impractical to verify the savings using the above approach then it may be necessary to change the measurement boundary or conduct a calibrated simulation.

Q. The facility is undertaking several EEIMs over several years. What approach to M&V should be taken?

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[3] Referred to in IPMVP as 'Option A'.

A. International guidance on Measurement & Verification is likely to point toward selecting a measurement boundary that isolates each specific measure, with due account being taken of indirect energy effects / interactive effects; calibrated simulation is also an option. However, in some cases the interactive effects can be complex, making it difficult to do cost-effectively or accurately. In other cases a suitable measurement boundary may involve overlapping EEIMs which are implemented at different times.

SEAI requires:

- EEIMs must be documented in an M&V Plan, or M&V Plans if EEIMs implemented and claimed at different times.
- EITHER 'whole facility' approach:
    - Engineering calculations be provided for each EEIM. Where savings from an EEIM exceed 0.5 GWh a particularly high standard will be expected. Engineering calculations must also quantify the interactive effects.
      AND
    - The utility meters demonstrate, either by direct comparison or analysis, a clear and persistent downward trend over time. In this case the energy savings for subsequent measures will be based on the measured and verified additional saving observed at the utility meter.
- OR 'retrofit isolation' approach:
    - Energy metering at a suitable measurement boundary to isolate the direct savings associated with a single or number of specific EEIMs.
      AND
    - Suitable Engineering Calculations to take account of the interactive effects of subsequent measures. In this case the energy savings for subsequent measures will be based on the energy metering, suitably adjusted for interactive effects of subsequent measures.
      AND
    - Utility meter readings be provided demonstrating, either by direct comparison or analysis, multi-annual energy use trends over time, along with the timings at which each measure began impacting energy use. This is required as supporting information.
- OR 'ISO 50001' approach:
    - SEAI's quality framework (Section 1.2) favours the employment of ISO50001. This approach is discussed below.

3.2.2.1 M&V Approach by Organisations with ISO50001

M&V should work in harmony with existing ISO50001 systems, thereby reducing the M&V burden.

As ISO50001 requires an energy review to be updated at defined intervals, this energy review should provide the basis of the M&V Plan and Report; indeed, if all the elements of an M&V Plan and Report are inc0rporated in the energy review, a separate M&V Plan and Report is not required.

In general the energy review will identify EnPIs and Energy Baselines (EnBs) associated with SEUs; if this is done at an appropriate level, changes in these will provide the basis for M&V of savings.

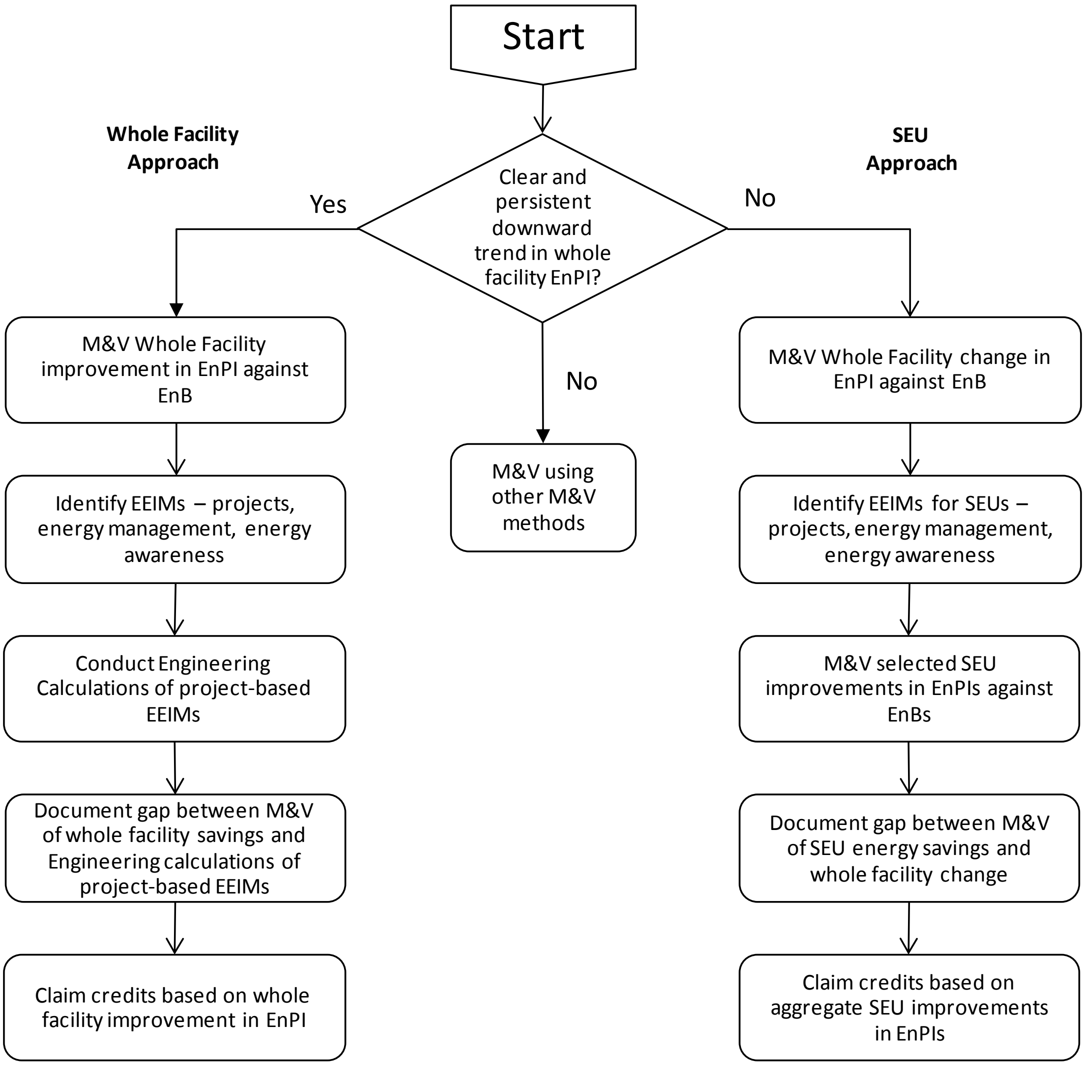
For organisations with ISO50001 certification, there are three M&V options, as illustrated below.

Claiming Energy Credits on Receipt of ISO50001

SEAI will allow organisations to claim in advance some energy credits on receipt of ISO50001 certification. The scale of the energy credits claimed in advance will be an agreed proportion of the organisations baseline energy usage. Thereafter additional energy savings credits must be claimed annually in arrears; the energy credits granted in advance will be deducted from the additional savings.

In order to claim energy saving credits an ISO50001 Synopsis M&V Plan and Report is required. An example Synopsis is provided in Appendix D, along with an example of a completed NREC Application.

It is generally expected additional savings will be achieved and claimed every year. In instances where energy increases are found, SEAI must be advised of this.



Where an organisation is adopting the SEU Approach, 'savings' cannot be achieved by simply transferring load from one SEU to another (e.g. by transferring activities from one building to another) – the net benefit must be demonstrated by including both SEUs.

Once an organisation selects an approach, they must persist using the chosen approach when claiming credits into the future.

3.2.3 Measurement boundary / M&V Boundaries

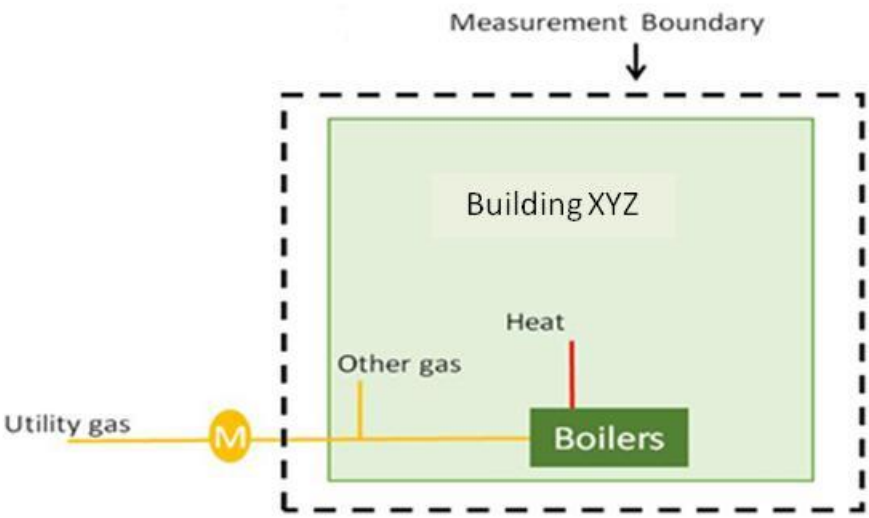
The M&V Plan must identify clearly the M&V boundary and any interactive effects beyond that boundary.

It is useful to sketch the measurement boundary. This should also identify any interactive effects beyond the measurement boundary, together with their possible effects.

Essential Requirement:

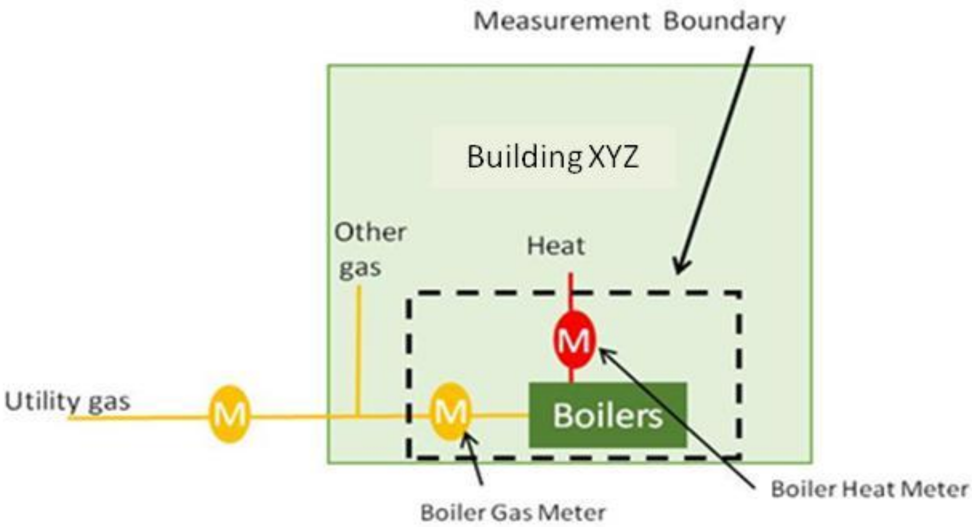
- Identify the measurement boundary
- Where there are a number of EEIMs and each is measured and verified individually as a separate sub-project, number each EEIM and identify the measurement boundary.
- Identify interactive effects and discuss their possible effect/impact.

Examples of typical measurement boundaries are illustrated below.



Whole Facility Measurement Boundary Example

The above measurement boundary would be applicable if multiple EEIMs were being conducted in the facility which have significant interactive effects, such as boiler upgrades with controls and insulation improvements. This boundary would capture all of these improvements.



All Parameter Measurement Example

In other cases it may be more appropriate to sub-meter the specific EEIM, as illustrated above.

3.2.4 Baseline Period

The baseline period should be a representative period of time, typically at least one operating cycle[4]. The duration of a full operating cycle will vary:

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[4] IPMVP Vol. 1 -2012 states "The baseline period should be established to represent all operating modes of the facility. This period should span a full operating cycle from maximum energy use to minimum". It also provides further guidance on this topic.

- In the case of building energy associated with space heating or cooling the duration is typically a year as this allows for variations in weather
- In the case of occupancy control of lighting in a busy environment a full operating cycle may be a week, whereas a quiet environment such as a cellular office may require several weeks.
- In the of daylight control of lighting, this varies over 6 months, but is highly predictable as daylight hours do not vary year to year, creating the potential for a simple calibrated simulation model.
- Occupancy and daylight control of lighting (combined) will reflect the longer of the individual cycles.

Static Factor Requirements - Whilst due consideration must be given to Static Factors, it is only necessary to identify those Static Factors that are at risk of changing during the term of the Reporting Period; as the Reporting Period may be short, the number of Static Factors to be tracked is likely to be small.

Regression Analysis - Where undertaking a regression analysis, the source of any regression analysis input data must be stated, as well as any basis for adjustment. If conducting a degree day regression analysis, one should test different base temperatures (e.g. 14.5, 16.5 degC) as default base temperatures (typically 15.5 degC) may not be appropriate for the facility in question.

Baseline Documentation - The baseline data set (actual meter data and estimated data) must be included in the M&V Plan in tabular form, typically in the Appendix. There may be separate tables for each energy type (e.g. electricity table separate from gas table). Associated Independent Variables must be included, as illustrated:

Month	Gas Sub-meter 1 [unit kWh, converted @ 10.6kWh/m3]	Gas Sub-meter 2 [unit kWh, converted @ 10.6kWh/m3]	Degree Days (15.5degC base, Dublin Airport)	Comment
Jan 2013	12,300	78,450	451	Actual values

3.2.4.1 Dealing with insufficient baseline data

Whilst it is optimum to have a full operating cycle of baseline data (both metered energy and independent variables) recorded at an appropriate frequency, unfortunately this is not always available. Some lateral thinking may be required and it is recommended to:

a. Focus on establishing the efficiency of the original installation
b. Focus on what measured data is available during the baseline period, and how to use this
c. Focus on the fixed nature of the original installation
d. Use conservative defaults where allowed.

A number of approaches and examples are discussed below, but it is the responsibility of the M&V practitioner to use their judgement in assessing their suitability for a particular project.

a. Original installation efficiency

Operate the existing installation over a shorter period but at different loads that represent the range of operating conditions of a normal operating cycle. This may be achieved, for instance, by using the BMS to simulate different operating loads of a boiler and establishing its efficiency at different points. Where such an approach is adopted, the logic by which baseline and reporting period data can be related must be clear.

For example, a boiler heating system is to be replaced with more efficient units.

- Install a gas meter and heat meter, and measure the efficiency of the original heating system at a number of heat loads/outputs (e.g. 10%, 20% … 100%). Establish an equation (Regression) between heat load and gas use.
- Install the new system and record the heat load profile of the system at frequent intervals (e.g. 15 minutes) over the course of the entire reporting period. Record actual gas use.
- For each interval, apply the equation for the original installation to predict what gas use by the original system would have been.
- Subtract actual gas use from predicted to establish the avoided energy use (i.e. energy saved during the reporting period).

b. Use limited measured data

Extrapolate smaller or incomplete data sets to a full operating cycle provided:

- the extrapolated data is clearly identified (e.g. by colour code or footnote)
- the extrapolation methodology is clearly identified (including equations)
- the logic for the method is explained
- all assumptions are identified
- calculations result in a conservative outcome (i.e. err on the side of underestimating savings)
- the implications of this approach on the overall accuracy of the M&V savings is discussed. A statistical analysis is not required
- reporting period energy data is recorded for a full operating cycle (i.e. extrapolation of both baseline and reporting period energy data is not allowed).

For example, an oil boiler is being replaced with a gas unit. Oil delivery data is available for 2 successive deliveries covering 20 weeks and it has been confirmed that with each delivery the tank was filled; the data of the previous fill is known, but no records are available prior to then. The gas boiler is installed with a meter and weekly readings are taken along with weekly degree days for 12 months.

- The reporting period regression demonstrates a strong correlation between gas use and degree days, suggesting that a regression analysis of oil versus degree days would be valid.
- Use the reporting period regression to predict what the gas use of the new boiler would have been in the baseline year.
- Use the three oil delivery dates to establish a regression line of degree days versus oil use (2 points). Use this line to calculate what the oil use would have been for the entire baseline year.
- Subtract annualised oil use from predicted gas use for the baseline year to establish savings.

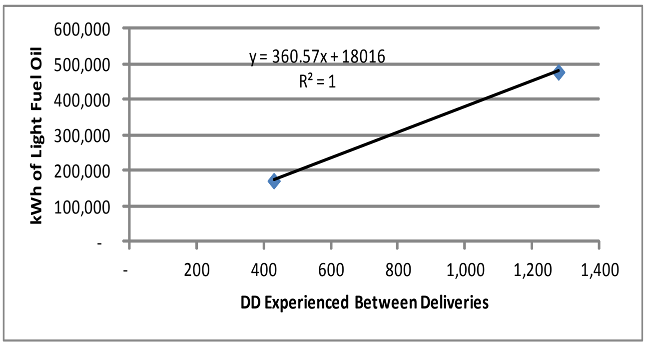
Baseline Analysis - Old Oil Boiler

Delivery Invoices			
Date	Litres*	kWh	DD**
17/09/2013	20,500	208,690	
02/12/2013	17,000	173,060	430
30/04/2014	47,000	478,460	1,277

Conversion factors	Value	Source
Litres to kWh (GCV)	10.18	SEAI - Comparison of Energy Costs Jul 15 - Kerosene

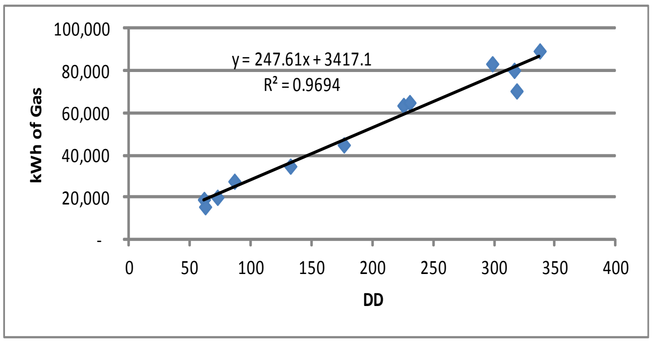
* The client has stated the tank was filled every time oil was delivered
**DD between delivery dates - source degreedays.net - 15.5 deg C base

Number of days between regression points 149



Reporting Period Analysis - New Gas Boiler

Date	Gas used (m³)*	GCV of gas (kWh/m³)**	kWh	DD(degreedays.net-15.5 °C base)
Sep-14	1,815	11.02	20,000	72
Oct-14	3,176	10.95	34,778	132
Nov-14	5,717	11.12	63,572	225
Dec-14	7,260	11.05	80,218	316
Jan-15	8,167	10.95	89,428	337
Feb-15	6,352	11.09	70,445	318
Mar-15	7,441	11.2	83,339	298
Apr-15	5,808	11.18	64,929	230
May-15	4,083	10.99	44,877	176
Jun-15	2,495	11.07	27,625	86
Jul-15	1,724	11.01	18,983	61
Aug-15	1,407	11.05	15,542	62
Total	**55,445**		**613,736**	**2,313**



* New gas meter logged on BMS - diaphram meter, sized for expected gas flow range
** Source utility bills

Calculation of Savings

The correlation between DD and gas use has proven to be strong according to regression analysis done on new gas boiler, with an R^2 value of 0.969
By using the regression curve of the new gas boiler, it is possible to estimate how much gas the new gas boiler would have used in the baseline year
The below table calculates how much gas the new gas boiler would have used if it was installed during the baseline year by using the formula 247.61xDD+3217.1

Date	DD(degreedays.net - 15.5 °C base)	Predicted gas boiler usage (kWh)
Sep-13	88	25,207
Oct-13	119	32,883
Nov-13	270	70,272
Dec-13	260	67,796
Jan-14	303	78,443
Feb-14	274	71,262
Mar-14	267	69,529
Apr-14	182	48,482
May-14	133	36,349
Jun-14	63	19,017
Jul-14	32	11,341
Aug-14	70	20,750
Total	**2,061**	**551,329**

Annualised oil boiler consumption calculation

Regression formula over 149 days of operation is	360.57 x DD + 18016
Formula to calculate oil use over a year*	360.57 x annual DD + (18016/149)x365
Annual DD during Baseline year	2061
Annualised oil usage in baseline year (kWh)	**787,268**
Predicted gas usage during baseline year (kWh)	**551,329**
Savings from new gas boiler installation (kWh)	**235,939**

*Non space heating portion of heat use deemed constant as per Reporting Period regression

c. Fixed baseline

Many ventilation or pump projects involve going from a fixed speed to variable speed control of the same fan/pump and motor. In such cases, when the project works are being undertaken a set of readings can be taken and then BMS/SCADA recording of measured parameters used instead of energy metering.

In the case of lighting projects with controls the existing installation may be manually switched and, provided the existing switching patterns are regular, this may be combined with the existing lighting load to establish baseline use. However, the impact of new controls on the reporting period use must be measured.

Example: A fixed speed Air Handling Unit has a heating coil and is scheduled by the BMS. An EEIM is installed involving fitting a Variable Speed Drive (VSD), controlled based on CO2 sensor in the return air duct. No baseline data exists and metering electricity and heat use by the individual AHU is considered too costly for the scale of project.

During commissioning, readings of fan power and air volume are taken at fan speed increments of 10%. During the reporting period of 1 year, the AHU fan speed and the air temperature difference across the heating coil are recorded at 15 minute intervals.

The data is summarised in the table below. "Baseline" energy is calculated by calculating what the energy use of the AHU would have been for each 15 minute interval had the AHU been operating at fixed speed.

Measured Parameters Recorded During Commissioning								
% fan speed	40%	50%	60%	70%	80%	90%	*100%	Comments
Fan Power Consumption (kW)	1.0	2.0	3.5	5.5	8.2	11.7	16.1	Measured using RMS power analyser
Measured air volume rate (m3/s)	6.2	7.7	9.2	10.7	12.2	13.7	15.2	Calculated using a matrix of duct velocity readings taken by a hot wire anemometer
Logged and Calculated Parameters During Reporting Period								
% fan speed	40%	50%	60%	70%	80%	90%	*100%	Comments
Amount of hrs spend at fan speed	3,800	523	1,080	1,352	600	725	680	Logged on the BMS via a modbus VSD interface
Heat used at different fan speeds (kWh)	50,000	10,000	22,000	18,000	89,000	130,500	172,000	BMS logs delta T of the air across the coil on a 15 min basis. This is multiplied by air volume recorded at each fan speed x hrs at that speed x density of air x specific heat capacity of air
Calculation of Energy Savings								
% fan speed	40%	50%	60%	70%	80%	90%	Total Savings	Comments
Electrical fan power savings (kWh)	57,380	7,374	13,608	14,331	4,740	3,190	**100,624**	Example of savings calculation at 40% speed = [(16.1 - 1) x 3,800]
Thermal savings (kWh)	72,581	9,740	14,348	7,570	21,885	14,288	**140,412**	Example of savings calculation at 40% speed = [((50,000/6.2) x 15.2) - 50,000]
Gas savings (kWh GCV)	90,726	12,175	17,935	9,463	27,357	17,860	**175,515**	Gas savings = Thermal Savings / Boiler Efficiency (80%)
Assumptions and Notes								
* At 100% fan speed the energy use by the AHU is the same as if there was no VSD installed. Savings are measured against this.								
Density of air	1.204	kg/m3						
Specific heat capacity	1.006	kJ/kg°C						
Boiler measured seasonal efficiency	80%	Heat out and gas in are measured in the boilerhouse during reporting period (based on GCV)						

d. Conservative Defaults

The use of conservative defaults is discussed in section 2.4.

For example if a new, more efficient boiler has been installed along with a new gas meter:

- Original boiler gas use unknown
- Original boiler rated peak efficiency is 80% (GCV)
- New boiler rated peak efficiency is 90% (GCV at 80/60 degC flow/return temperatures)
- New boiler used 120,000 kWh of gas in reporting year (measured)
- Existing boiler would have used 135,000 kWh in reporting year (120,000 x 90% / 80%)
- Avoided Energy Use = 135,000 – 120,000 = 15,000 kWh

Note: this is a conservative default as it is likely that the seasonal efficiency of the original boiler would be considerably lower than that of the new boiler.

Essential Requirements:

- Identify the Baseline Period (start and end dates).
- Note the duration of a complete operating cycle and whether or not the Baseline Period data (including independent variables) is complete in full with no gaps.
- Where the Baseline Period data is not complete, explain the methodology adopted to work around this.
- Baseline Period dataset should be included in M&V Plan appendix.
- Where key parameter measurement is selected, report the values to be used for all estimated values. Identify the source of these estimated values and justify their use.
- Document Static Factors as appropriate.

3.2.5 Reporting Period

The M&V Plan must document the Reporting Period; as with the Baseline Period, the Reporting Period must be at least one operating cycle. It must identify the energy data, independent variables and static factors to be recorded during the reporting period. These should mirror those identified in the baseline period.

Essential Requirement:

- Identify the reporting period (start and end dates).
- State the duration of a complete operating cycle and duration of the reporting period (should be the same).
- Identify the energy data, independent variables and static factors (i.e. record changes to static factors) to be recorded during the reporting period.

3.2.6 Normalised Savings or Avoided Energy Use

In general the decision to use Normalised Savings or Avoided Energy Use to determine the level of energy savings from an EEIM is at the discretion of the OP. However, the Avoided Energy Use approach makes completion of the M&V Report less onerous as it involves simply applying reporting period independent variable data to the algorithm (e.g. regression equation) established during the M&V Plan. A disadvantage of this approach is that to fully report "avoided" energy use one must have an entire operating cycle of reporting period independent variable data.

Normalised savings involves adjusting the baseline and/or the reporting period energy use to the same set of fixed normal conditions; this may be the baseline period or 30 year climate data. 30 year climate data is useful to stabilise savings and to reduce the effect of fluctuations with current conditions.

Essential Requirement:

- State the savings calculation method is Avoided Energy Use or Normalised Savings.
- Where Normalised Savings are used, advise what the Normalisation period is.

3.2.7 Analysis Procedure

The analysis method and resulting equation of any analysis of baseline energy consumption against the independent variable(s) - such as heating degree days, cooling degree days, bed nights - must be included (with possible references to appendix).

In many cases simply pasting in the results from an excel regression analysis will be sufficient. Where there is only one independent variable, a simple plot with line of best fit, associated R^2 and equation in the format "y = mx + c" is adequate. Where there are a number of independent variables the associated excel regression analysis results must be included.

If there are different meters or different energy types, then each will have its own analysis.

Where account is being taken of interactive effects, a logical explanation of how the savings (or increase in energy use) associated with the interactive effect is calculated (or metered) and any assumptions is required.

Essential Requirements:

- Specify step by step how avoided energy use will be calculated at the end of the reporting period, taking account of both the independent variables and interactive effects. For example:
    1. The baseline regression equation (algorithm) for gas use will be applied to reporting period heating degree days to calculate adjusted baseline period energy for each week.
    2. The results will be totalled to calculate the kWh for one year.
    3. Actual reporting period utility metered gas use during the reporting period will be totalled for 1 year and the kitchen sub-meter gas use subtracted from this.
    4. Actual reporting period gas volumes will be converted to kWh using the weighted average kWh conversion factor from the utility bills.
    5. Reporting period gas volume will be subtracted from adjusted baseline gas use.
    6. Due account will be taken of static factor adjustments if required.
- Provide the equations / algorithms.
- Provide a worked example to illustrate the exact data analysis procedures, algorithms and assumptions to be used in the M&V Report. Although a spreadsheet may be identified as an attachment, spreadsheets are unstable and so the spreadsheet values should be pasted into this document (possibly as appendix).

Q. What if I cannot find a clear independent variable?

- There does not always have to be a clear independent variable and a direct comparison of energy use before and after (including relevant adjustments) which demonstrates a consistent and persistent saving over an appropriate time is acceptable.
- The baseline and reporting period should be sufficiently long to demonstrate either by direct comparison (or analysis) that there is a clear and persistent trend before and trend after which is distinguishable from day to day fluctuations.
- Consider using key or all parameter measurement instead of whole facility and identify a suitable Independent Variable for the new measurement boundary.

3.2.8 Meter Specification

Specify recording intervals where recording is automatic, or recording dates and times where recording is manual.

It is important to appropriately select and to manage the installation of energy meters to ensure that the installation quality/method does not compromise device accuracy. Meters should be selected and installation specified by a competent person. For instance:

- In the case of heat meters, the meter should be sized to the expected normal operating flow range, and not to the size of the pipe; orifice plate meters are particularly inaccurate when used outside their design flow range.
- Heat meters should be installed with due consideration to minimising turbulence created by pipe bends.
- Electrical current transformers must face the correct direction and the current transformer and voltage connection for each phase must be connected to the meter at the point for that phase (rather than mixing the phases up).
- Electrical current transformer ratios must be correctly programmed into the electricity meter.

For non-utility meters "witnessing protocol, meter commissioning procedure, routine calibration process and method of dealing with lost data" are not required, but meter and logger readings must be sense checked. Calibration certificates are not required.

All meters used should be listed and referenced; see sample meter table below.

Meter point	Type	Make & Model	Recording intervals	Note	Suitability*
Utility Electricity	Not required for utility meters	Not required for utility meters	Quarter hourly	MPRN 1000YYYYYYY	
Utility Gas	Not required for utility meters	Not required for utility meters	Daily	GPRN No XXXYYY	
Plant Room Electricity Sub Meter	CT Panel Mounted	Socomec XYZ	Quarter hourly	Connected to site BMS and data logged at 15min intervals.	
Boiler Gas Meter	Diaphragm Meter	Actaris XYZ	Quarter hourly	Installed in 2013 in advance of EEIM. Connected to site BMS and data logged at 15min intervals.	
Boiler Heat Meter	Packaged Heat Integrator	Kamstrup XYZ	Half hourly	Installed in 2013 in advance of EEIM. Flow device selected with due consideration to qp/q impact on accuracy.	

* Suitability: Confirm all meters are in good working condition. Provide a brief note on what makes each meter suited to the application. If a meter is not well suited, but has been used for practical reasons (e.g. to keep metering costs proportionate), provide justification in detail.

Essential Requirement:

- Table of meters as specified.

3.2.9 Persistence of Savings

Energy savings are only of national benefit if they persist to 2020 and beyond. Identify any risks affecting the persistence of savings during the Reporting Period and beyond. Identify risk mitigation measures and identify who is responsible for managing these risks.

3.2.10 Expected Accuracy

In general SEAI does not require a statistical analysis of overall accuracy (such as +/- 10% precision with 90% confidence). Identify aspects that reduce the accuracy of the calculations and discuss what measures have been taken to address or minimise these. The aspects to consider are:

- Errors or shortcomings in baseline energy and independent variables (such as incomplete data). The accuracy considerations associated with data extrapolation, discussed in Section 3.2.4 above can be referred to.
- Modelling errors (such as low co-efficient of determination, R^2, for regression line)
- Sampling errors
- Metering errors (should reflect meter suitability discussed above)
- Estimated parameters errors associated with Key Parameter Measurement
- Others…

3.3 Preliminary and Final M&V Report

A Final M&V Report is required. In cases where the Reporting Period is relatively short, the data may be gathered and Report completed simultaneous to the Plan; nevertheless, a separate M&V Report is required.

Due account must be taken of changes in static factors.

3.3.1 Preliminary M&V Report

If the Reporting Period is long and the OP wants to claim energy credits before the period ends, a Preliminary M&V Report may be completed and used as the basis for claiming energy credits provided data is available for a reasonable range of operating conditions and a trend can be established. For example, 8 weeks of weekly boiler data during the heating season is likely to be acceptable, but 8 weeks of boiler data during the summer is not.

As a Preliminary M&V Report is based on a curtailed reporting period, the accuracy will be lower and so a conservative view must be taken of the outcome (e.g. by applying a factor of less than 1 to the calculated savings); in general, the shorter the reporting period, the more conservative the outcome should be.

Energy savings credits may be claimed based on the annualised energy savings using an appropriate and conservative method.

If a Preliminary M&V Report is used and an NREC form submitted on this basis, then:

- A Final M&V Report must be completed at the end of the Reporting period.
- The energy credits claimed based on the Preliminary M&V Report should be compared with those of the final M&V report and if the difference exceeds 5%, SEAI must be advised of this.
- Where the energy credits claimed based on the Preliminary M&V Report are less than those claimed on the Final M&V Report, the OP may claim the additional energy credits by completing an additional NREC form the following year.

3.3.2 M&V Report Format

The cover or first inside page of the Report must include the table identified in Section 3.1, duly completed. The Preliminary M&V Report should follow the same format.

The M&V Report will contain the following information as a minimum:

- Introduction
    - Refer to M&V Plan
    - Identify the Reporting Period
- Observed energy data during the reporting period (tabulated)
    - To include description and justification for any corrections made to observed data
- Observed independent variable data during the reporting period (tabulated)
    - To include description and justification for any corrections made to observed data
- Static factors
    - Note any changes and identify if non-routine adjustments were required. Include an explanation of the change in conditions since the Baseline Period, all observed facts and assumptions, and the engineering calculations leading to the adjustment.
- Analysis of savings
    - Repeat and use the process and algorithms identified in the M&V Plan
    - If a preliminary report has already been submitted then compare verified savings from the full report with those savings quantified in the preliminary report and submitted to SEAI in the NREC application form.
- Conclusions
    - Identify and discuss any factors affecting the accuracy that were not identified in the M&V Plan
    - Discuss the difference between verified savings and those savings calculated in any preliminary report submitted to SEAI in the Energy Credit Application Form. Identify any lessons learned.
    - State if, in your opinion, the verified savings will persist. Identify any concerns you may have, possibly associated with host behaviour.

4. Engineering Calculations

4.1 General

As discussed in Section 3, Engineering Calculations may be used as an alternative to M&V:

- For projects employing specific well-proven technologies approved by SEAI.
- For smaller scale NREC Applications and sub-projects as identified using the derogation decision tree.

Engineering calculations may be completed using standard calculation tools (Section 4.2) or bespoke calculations (Section 4.3). Bespoke calculations are likely to be in a spreadsheet.

It is the responsibility of the OP to maintain adequate records of the calculations, including inputs, assumptions and outputs so that the results can be replicated; these records must be available for an SEAI Audit on request. As spreadsheets are easily changed, pdf records of worksheets may be appropriate. Records must include project title, energy supplier name and contact details, host organisation name and contact details, name of person who prepared the engineering calculations and their qualifications/competency.

Summary information must be included in the NREC application form (refer to this for details).

For energy savings quantified using engineering calculation which use some metered data, the meter make and model, location and reference (e.g. serial number) should be included in the records (e.g. calculation spreadsheet). The recording interval and period for which the data is used must be identified.

4.2 Standard Calculation Tools

It is the responsibility of the OP to establish if a particular tool is suited to calculating savings in a particular project. Where calculation tools are used, identify the tool, project data inputs, outputs and assumptions. In some cases it may be possible to copy and paste these from the tool.

4.2.1 SEAI Calculation Tools

SEAI have calculation tools that have been designed to cater for many types of technologies and may be suited to particular projects. These are available from the SEAI website under Business-Resources-Technology Assessment Tools.

http://www.seai.ie/Your_Business/Resources/Technology_Assessment_Tools/

4.2.2 SBEM

To calculate energy savings associated with fabric upgrades, SBEM may be used to do separate models for existing and proposed, the difference representing the savings. However, the SBEM model is based on standard parameters, particularly occupancy hours. As a result, adjustments must be made to the model outputs to reflect actual operating conditions or other significant building-specific differences.

4.2.3 Other Calculation Tools

If other calculation tools are identified by an OP, these should be submitted to SEAI for approval **prior** to their use.

4.3 Bespoke Calculations

Bespoke calculations may be used. The following principles apply:

- Calculations must be based on engineering principals.
- If a calculation is based on a method identified in a handbook or guide (e.g. CIBSE, AHSRAE, etc.), identify the source and provide full details of edition and section.

- Calculations must be presented in a transparent manner. Where an output is a product of a complex calculation either the formula should be provided or the calculation done in several steps that allows one follow the logic.
- Calculations must be clear enough for a technical reader to follow.
    - Calculations should be based on the combination of hours (before and after) and load in kilo-Watts (before and after). Each should be separately identified.
    - Units must be identified.
    - Conversion factors should be clearly stated, including associated units as appropriate; this is particularly important where gas volume is converted to energy.
    - Assumptions/estimates must be clearly identified and the underpinning justification or reference material for this assumption.
    - The source of measurements or readings should be identified. Simply presenting a kWh value without identifying the meter it was taken from is inadequate.
- The unit of energy is to be kilo-Watt hours (kWh). Thermal energy is to be quantified on a Gross Calorific Value basis.
- Due account must be taken of variations in load, including seasonal variations. For example, a 500kW boiler operating in a heating system scheduled to run 50 hours a week will not necessarily use 25,000kWh every week of the year.
- Due account must be taken of inherent system losses or efficiencies. Unless site measurement is performed conservative default values must be used. For example:
    - Discharge lighting with electro-magnetic control gear will have an associated loss.
    - A heating system's seasonal efficiency will be lower than a boiler's rated peak efficiency
    - A cooling system's seasonal performance will be lower than a chiller's rated co-efficient of system performance.
- When making assumptions, identify their origin clearly or the logical basis of these. Ideally identify an independent reference.
- Where multiple EEIMs are implemented, and these interact with each other, double counting must be avoided. For instance, if more efficient light fittings are installed in conjunction with occupancy controls, the total savings is NOT the sum of the respective savings.
- Measured readings, such as historical energy use records, may be incorporated.

4.4 Examples

4.4.1 Lighting with controls

Sample Engineering Calculation - Light fitting replacement and occupancy controls											
Status	Fitting Type	Area of Use	Load				Hours			Electricity	Notes
			Lamp load per fitting Watts	Ballast losses (ref App C)	No. Fittings	Total Load kW	Annual Switched hrs	Control Factor	Total Hours	(Total hrs x Total load) kWh p.a.	
Pre EEIM	Twin 58W T8 fitting with electro-magnetic control gear	Cellular offices and meeting rooms	116	15%	300	40.0	3,120	100%	3120	124,862	Fitting load based on lamp wattage + assumed 15% control gear loss. Fittings on 12 hours/day, 5 days/week, 52 weeks/year
Post EEIM	Twin 70W T5 fittings with electronic control gear (philips model xyz)	Cellular offices and meeting rooms	70	0%	295	20.7	3,120	75%	2340	48,321	Light fitting data sheet attached. 5 fittings in unoccupied spaces manually switched off and 'switch off' notices put at the switches. Occupancy control factor assumed based on observed activity over a normal working day. As this is an Eng. Calc. measurement of occupancy patterens is not required.
									Saving	**76,541**	

4.4.2 Example - Boiler Upgrade, No Measured Data

Boiler characteristics					Source / Assumption
Existing					
Old Brittania abc	Capacity	kW	500		Nameplate
	Rated efficiency	gcv	80%		Nameplate
Proposed					
Rendamax xyz	Capacity	kW	450		Datasheet
	Rated efficiency	gcv @ 80/60	90%		Datasheet
Building Energy Use					
Option i: Measured use over 12 months, e.g. oil deliveries (Best)					No data available
Option ii: Peak load x Equivalent full load hours calculation (OK)					Selected
Option ii: Peak load x Equivalent full load hours calculation	Method adapted from Oughton,D.R., and Hodkinson,S. (2002) *Faber and Kell's*				
Building peak heating load			405	kW	Calcs used to size new boiler.
Heating degree days			2063	kWh/m2 p.a.	Dublin Airport, 15.5degC, Sep-May
Temperature rise due to internal heat gains			3	degC	Faber&Kell's Table 23.5
Factors relating building characteristics to inside and outside design temp			1.22		Faber&Kell's Table 23.6
Factor for intermittent use over 5 days of slow response system in heavy bui			0.81		Faber&Kell's Table 23.7
Factor for occupation over 12 hours in heavy building			1.03		Faber&Kell's Table 23.8
Equivalent full load hours			2,100	hrs	Calculated
Annual heat load			850,426	kWh	Calculated
Savings					
Existing fuel use			1,063,032	kWh	Annual Heat Load/Exisitng Boiler Eff
Proposed fuel use			944,917	kWh	Annual Heat Load/Proposed Boiler Eff
Calculated savings			118,115	kWh	By subtraction

5. Evidence of Project Implementation

The OP is responsible for ensuring that the energy credits being claimed are real and that the EEIM has actually taken place. A declaration to this effect must be made in the NREC application form under Section 2h. Evidence that a project has been carried out must be retained by the OP. For example:

- Photographs: Show before and after installations which are to include name plates of any equipment updated and where applicable a schedule of equipment installed. If these photos were supplied to the OP by a host site then a signed declaration to their authenticity must also be provided by the host.
- Lighting Upgrade – Photograph each lamp type (original and new) as well as a sample of areas retrofitted (before and after).
- Boiler Upgrade – Photograph old and new boiler name plates and show before and after pictures.
- Controls Upgrade – Take screenshots of BMS graphics before and after. If graphics do not exist then photograph field devices installed.
- Contractor invoices: Copies of paid contractor invoices may be retained as evidence by the OP.

It does not matter if the project savings were calculated or measured and verified – evidence is required in both cases.

6. Synopsis M&V Plan and Report Template

6.1 General

SEAI does not require the M&V Plan or M&V Report to be submitted; the OP must retain these records in the event of an SEAI Audit. SEAI requires a Synopsis M&V Plan and Report.

If multiple sub-projects have been measured and verified separately, these should be submitted as a single, overall Synopsis M&V Plan and Report, perhaps with different sections for each sub-project.

Use the format and guidance below to complete and attach the Synopsis to the NREC form; it is expected this will typically be 2-4 pages once complete (may be longer for multiple sub-projects). Refer to Appendix A for completed examples.

It is essential to prepare the Synopsis with the reader in mind and convey succinctly what the EEIM is and how it was measured and verified. Like an Executive Summary, it is intended to be high level, but include essential elements. If the Synopsis is unclear it is more likely that SEAI will request further information and/or audit the full M&V Plan, so time invested in producing a good quality document is likely to reduce your time required later for clarifications.

6.2 Contents of Synopsis M&V Plan and Report

EEIM Intent

- A clear, succinct statement describing the nature of the EEIM .
- A clear, succinct statement of how the EEIM saves energy.
- It should be possible to paste this directly from Section 1 of the M&V Plan.
- List of EEIMs installed. Where more than one, use reference numbers and titles that match the M&V Plan.

M&V Approach & Measurement Boundary

- Describe briefly the approach taken to M&V.
- Identify the measurement boundary.
- Where there are a number of EEIMs and each is measured and verified individually, identify both the M&V approach and the measurement boundary for each (using same reference numbers an titles)
- Where key parameter measurement is selected, identify the estimated parameter and measured parameter.
- Identify indirect energy (interactive) effects and discuss their relevance.

Baseline Period

- Identify the baseline period, energy data and recording interval.
- Note the duration of a complete operating cycle and whether or not the Baseline Period data for that period is complete.
- Identify the independent variable(s) being recorded and source, e.g. Heating Degree Days to 17degC base, source: Dublin Airport.
- Identify the static factors being recorded.

Reporting Period

- Identify the duration of the full reporting period.
- State the duration of a complete operating cycle, which should be the same as the Reporting Period.
- If this is a Preliminary Report, identify also the duration of the preliminary reporting period.

• Identify the energy data, independent variables and static factors recorded during the reporting period.
Basis of Adjustment • Identify the operating conditions to which all energy measurements are being adjusted. For instance, this may be the baseline period, the reporting period or a normalisation period. • If using a normalised period, identify when this, e.g. 30 year climatic data.
Analysis Procedure • Identify the intervals used for analysis, e.g. weekly, monthly. • Step by step explanation of how savings will be calculated at the end of the reporting period, taking account of both the independent variables and interactive effects. • Identify the equation/algorithm used to reflect the relationship between energy use and selected independent variables, and identify the parameters, e.g. y = 357 x + 8700 where x is heating degree days and y is gas use. • Explain how savings are annualised including any factors used to ensure conservative outcome (where appropriate).
Baseline & Reporting Period Energy Use • Provide the baseline energy use and the reporting period energy use totals. These unadjusted figures provide a high level sense check of M&V analysis outcome. • These must be comparable figures. For example, if this is a Preliminary Report based on July-October data, provide the total for these months in both the Baseline and Reporting period. • State if these are Preliminary or Final M&V Report results.
Analysis of Savings • Provide a high level analysis of the energy savings using the analysis described in the M&V plan.
Other Observations • Identify any factors affecting the accuracy that were not identified in the M&V Plan. • Discuss, in your opinion, if the verified savings will persist. Identify any concerns you may have, possibly associated with host behaviour. • Other at your discretion.

6.3 ISO50001 Synopsis M&V Plan & Report Template

In a Host organisations where ISO50001 has been implemented, the Synopsis M&V Plan & Report which will be submitted as an appendix to the NREQ form will follow the format as follows;

Whole Facility or SEU Approach • State which approach has been taken to M&V and describe the reasons why (refer to section 3.2.2.1). • Once a host organisation decides which approach to take it must follow this approach in every subsequent year.
Whole Facility EnPIs Vs EnB • Document the sites energy performance data since the baseline year. To include actual and adjusted energy use, relevant variables and EnPIs.

Identify EEIMs • List and describe the EEIMs that have taken place in the reporting year.
Engineering Calculations or M&V • What is included here depends on what approach has been taken. • If the SEU Approach has been taken then M&V is required of the individual projects by verifying improvements in EnPIs for SEU against EnBs • If the Whole Facility Approach has been taken, conduct engineering calculations of project based EEIMs
Explanation of Gap Between Calculated or Verified Savings and Whole Facility Use • The gap between the calculated or verified savings and the whole facility use needs to be identified. There must be an attempt to reconcile the difference and explain why this gap occurs.

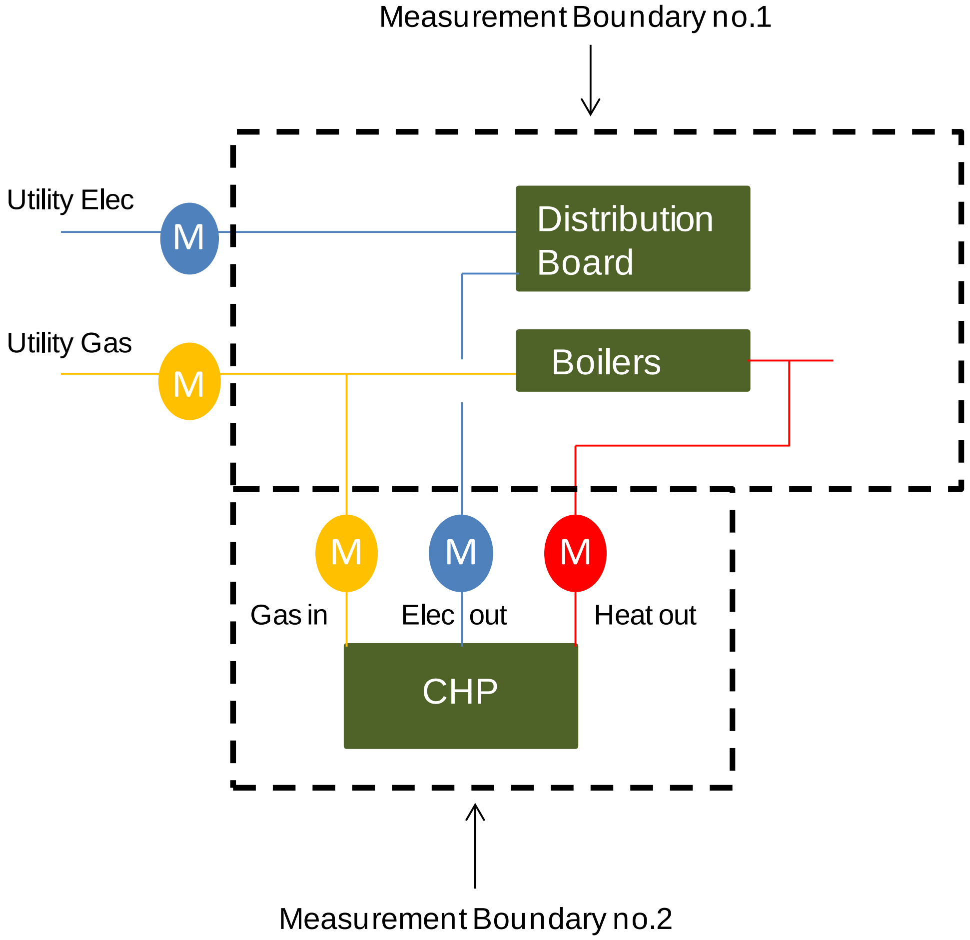
Refer to Appendix D for a worked example.

7. FAQs

What is the methodology for calculating CHP energy savings?

Where an EEIM within a facility includes a CHP, the primary energy savings must be calculated using the methodology outlined in the CHP Directive (Directive 2004/8/EC) Annex III. There is a supporting spreadsheet available on the CER website which simplifies the calculation for the M&V practitioner. This spreadsheet can be found within the 'Certification Process for High Efficiency Combined Heat and Power' publication on the CER website (www.cer.ie).

Where a facility is undergoing numerous EEIMs with concurrent Reporting Periods and a Whole Facility approach to M&V is being used, it is necessary to calculate the CHP energy savings separately to the rest of the facility. The Reporting Period energy use for the other EEIMs in the building must be adjusted to reflect what the facilities consumption would be like if the CHP was not there. The energy savings figures can be combined at the end to calculate the total primary energy savings for the facility.



What figure should I use to convert m^3 of gas or litres of fuel oil to kWh?

When converting units such as litres or m^3 of a fuel to kWh the gross CV factor must be used. Refer to Appendix B for guidance.

How do I convert measured heat savings into fuel energy savings?

The factor used will depend on the level of information available on the boiler generating the heat.

- If no data is available then a factor of 1 can be used as this is the most conservative.
- Alternatively use the boiler seasonal rated efficiency and keep evidence of this on file.
- Alternatively use measured burner efficiency (from flue gas analysis) and keep evidence of this on file.
- Alternatively measure seasonal efficiency of boilers (heat out/ fuel in) - this is the most accurate.

A similar approach can be used for cooling units.

If a lighting upgrade improves the overall lighting level of the facility, can these be quantified as savings?

Where existing lighting levels are measured as being below a lighting standard, and where the lighting levels are brought up to this standard, these savings are eligible. However, for any increase in lighting levels above the standard, lighting savings are ineligible. Before, after and standard lux readings must be provided.

8. References

"International Performance Measurement and Verification Protocol", Efficiency Valuation Organisation, January 2012.

"M&V Guidelines: Measurement and Verification for Federal Energy Projects" Version 3.0, US Department of Energy.

"Measurement of Energy and Demand Savings", Guideline 12-2002, ASHRAE.

"Measurement and Verification of Energy Performance of Organizations – General Principles and Guidance" First Edition 2014, ISO50015.

Appendix A – Example Synopsis M&V Plan and Report

A.1 – Lighting Upgrade with Occupancy Controls and Daylight Dimming

Synopsis M&V Plan and Preliminary Report

EEIM Intent

This lighting EEIM replaces Fluorescent light fittings with LED fittings with integrated occupancy and dimming controls. The original lighting load is 150kW, and they operate for approximately 4000 hours per annum. The new LED lighting, combined with occupancy and dimming controls, are expected to reduce annual lighting energy usage by 50%.

M&V Approach & Measurement Boundary

Electricity use by the whole facility will be used as the measurement boundary for M&V of savings. Logged baseline period energy will be compared with logged reporting period energy at the measurement boundaries, with appropriate adjustments as described below.

It has been confirmed that the expected electricity savings will be >10% of annual facility consumption, and so savings will be clearly identifiable.

The site has a utility electricity meter with quarter hourly metering to record use.

There will be an indirect energy (interactive) effect on the boiler gas use which will increase due to the reduction in heat output from the lights. There is no chiller on site to provide cooling in summer.

Baseline Period

The Baseline Period for facility measurement is 2014.

The baseline energy is electricity use, measured at 15 minute intervals. 12 months of baseline data are available.

Electricity use is driven by occupancy (switching) and daylight hours (dimming). Occupancy varies during term, at end of term and during holidays, and so savings from occupancy controls will vary over the course of the year. Daylight hours change during the course of the year. A complete operating cycle is therefore 12 months.

In this case it has been concluded that occupancy and daylight hours are not well suited to analysis as independent variables, and their variations will be captured adequately over the operating cycle. As a result, there are no independent variables being recorded.

Static factors:

1. Lux levels will be measured and recorded at ten suitable locations points within the building.
2. The number of failed lamps shall be documented.
3. The number of lighting burn hours in the baseline period is assumed to equal building opening hours. Opening hours are noted.
4. Boiler heating season.

Reporting Period

The reporting period for facility measurement is August 2015-July 2016. This 12 month period will take account of season variances with daylight availability and variations in occupancy patterns. .

This is a Preliminary M&V Report, covering the reporting period September – November 2015.

During this period monthly electricity use was recorded.

There were no changes in static factors during the preliminary reporting period.

Basis of Adjustment

Electrical energy savings will be calculated by adjusting baseline energy use to reporting period conditions, where required, i.e. using the Avoided Energy Use (AEU) method.

Analysis Procedure

Baseline Energy p.a. = 2014 monthly electricity use (kWh).

Adjusted Baseline Energy = Baseline Energy +/- lux level adjustment[5] + energy that would have been used by failed lamps.

Reporting energy p.a. = 12 months measured electricity use (kWh).

Avoided energy p.a. = Adjusted Baseline Energy p.a. – Reporting Period Energy p.a.

Interactive effects p.a. = Avoided energy experienced during heating season / boiler efficiency[6].

As this is a preliminary report, savings are annualised by:

Avoided energy use p.a. = % Avoided energy use (3 months) x baseline energy use (12 months) x conservative seasonal factor.

Conservative annualisation of savings: The actual savings will be higher in the summer than those recorded during the preliminary reporting period due to lower occupancy rates and higher levels of available light. As a result, the annualisation method above is conservative.

Reporting Period Energy Use

This preliminary report is based on 3 months of reporting period data.

	Baseline Period (Jan.-Dec. 2014)	Baseline Period (Sept – Nov. 2014)	Reporting Period (Sep – Nov. 2015)
Measured Electricity kWh	1,457,941	393,068	328,577

Analysis of Savings

	Item	kWh	Comment
a	Baseline period energy (3 months)	393,068	
b	Lux level adjustment	0	Pre project lux levels were above 350 lux and post retrofit lux levels meet or exceed target lux levels.
c	Lamp failure adjustment	6,711	See note 1
d	Adjusted Baseline Energy	399,779	(a + b + c)
e	Reporting period energy (3 months)	328,577	
f	Avoided energy use (3 months)	71,202	(d-e)
g	Percentage savings (3 months)	17.8%	(f / d)
h	**Annualised savings (12 months)**	**286,642**	[g x d x (12/3)]
i	Heating season additional heating required	191,094	(h / 12 x 8) Oct-May = 8 months

[5] Note: If the baseline lux levels are below the design levels at the working plane (in this case 350 lux) and the retrofit results in improved lux levels, then the baseline will be adjusted up to account for this. Any increase above the standard required, i.e. above 350 lux, shall not be counted. If the project results in reduced lux levels then the baseline shall be adjusted down.

[6] Note: this additional thermal energy must be subtracted from the avoided energy once the final to primary energy conversion has taken place. This is then the total Primary Energy Savings figure.

j	Boiler nameplate efficiency (GCV)	85%	
k	**Interactive effects: additional boiler gas (GCV)**	**224,816**	(i / j) The gas extra gas use is shown as a negative figure in the NREC form.

Note 1: Lamp failure adjustment

No. of lamp failures	lamp wattage (W)	ballast losses	burn hours	annual kWh	Avg. Monthly kWh Adjustment
115	58	15%	3,500	26,847	2,237

Other Observations

- The interactive effect of the increased boiler gas use had a significant impact on the Primary Energy Savings. It would have been beneficial to do a degree day regression on the site gas usage before and after the lighting upgrade to establish a more accurate figure. It was assumed all elec. savings would have to be replaced by the boiler, but this may not actually be the case.
- In most cases the lux levels were improved, however the additional power used to improve conditions in the space was not accounted for.
- This is a Preliminary M&V Report and so all savings estimates made have been conservative. The % savings figure in the summer should be higher than given the lower occupancy rates and higher levels of available light. The full report will provide a more accurate savings figure and any adjustments made at that point.
- The LED fittings installed have a 50,000 hour life expectancy and so these savings should persist for the next 10-20 years. The owner has no plans to close or renovate the building in the near future.

A.2 – Numerous EEIMs conducted within a facility including CHP

Synopsis M&V Plan and Preliminary Report
EEIM Intent This project involved 3 separate EEIMs within a facility. 1. Installation of a CHP – This 150kWe/170kWth CHP will result in Primary Energy Savings. It has been sized to meet the base heating load and therefore maximise the heat use. All electricity will be used onsite. 2. Upgrade of fluorescent lighting with magnetic ballasts to LED with controls - The more efficient lighting, combined with occupancy controls are expected to reduce annual lighting power usage by 40%. 3. Upgrade oil boilers to condensing gas boilers with associated controls upgrade – The old 800kW boiler is being replaced with 2no. 300kW condensing gas boilers. The controls will also be upgraded to maximise the amount of time the boilers operate in condensing mode. The savings will be from the efficiency improvement.
M&V Approach & Measurement Boundary The measurement boundary is the Whole Facility, with utility meters provided the main source of measurement. Sub-metering of CHP gas, electricity and useful heat allows separation of the CHP contribution and for this to be measured and verified separately as per the EEOS guidance. As the whole facility approach is being adopted there is no interactive effect, except for the CHP which shall be treated separately, with the savings be added at the end. Refer to the boundary schematic on pg. 36)
Baseline Period The baseline period is 2014 calendar year, for which full energy and independent variable data is available. A complete operating cycle – taking account of variations in weather - is 52 weeks. The baseline energy is electricity (kWh), measured and recorded at 15 minute intervals; and gas (m3), measured and recorded at 15 minute intervals and converted to kWh using the monthly calorific value for gas (on gas invoices). Following an analysis of the relationship between different independent variables and electricity/gas use, the key independent variables were established for each. Electricity: Cooling Degree Days at 14.5degC base. Gas: Heating Degree Days at 15.5degC. The source of degree day data is degreedays.net. Static factors being recorded are indoor environmental standards and operating issues. Full details in M&V Plan.
Reporting Period The reporting period is 52 weeks from 26th April 2015 to 25th April 2016, representing a complete operating cycle. The Preliminary Reporting Period is 25 weeks from the 26th of April to the 18th of October 2015. This is not a complete operating cycle and a peak winter period is not included. As a result, the savings

quantified here are conservative.

The independent variables for the preliminary reporting period are HDD and CDD.

During the course of the reporting period to date there has been no changes compared to the baseline period.

Basis of Adjustment

Electricity and gas energy savings will be calculated by adjusting baseline energy use to reporting period weather conditions, i.e. using the Avoided Energy Use (AEU) method.

Analysis Procedure

The method used is to verify Avoided Electricity and Gas Use as if no CHP is installed, and separately the primary energy savings associated with the CHP. The CHP primary energy savings are to be calculated using the method required by the EU CHP Directives (2004/8/EC and 2008/952/EC).

The analysis will be completed using weekly data.

The process is:

(a) Calculate what the 2014 facility would have consumed (electricity and gas) in Reporting Period (April – October 2015) operating and weather conditions. This was established by applying the regression analysis algorithm documented in the M&V Plan to the Reporting Period data, identified above. This is referred to as "Predicted Electricity / Gas Use".
  - Predicted electricity use = 490.5 $CDD_{12.5degC}$ + 78,835
  - Predicted gas use equation = 1410 $HDD_{15.5degC}$ + 98,990

(b) Calculate what the energy use of the facility would have been during the Reporting Period if no CHP was installed, but all other EEIMs were installed.
  - The facility gas use in 2015 excluding the additional gas use by the CHP, and including an allowance for the additional gas use by boilers in the absence of CHP heat.
  - The facility electricity use in 2015 including utility electricity use and CHP electricity use, i.e. the electricity use the facility would have consumed if no CHP was installed.

(c) Subtract Electricity / Gas Use from Predicted values to establish Avoided Energy Use (or increases if number is negative) for the Reporting Period.

(d) Annualise the Avoided Energy Use for the Reporting Period by selecting the more conservative outcome of:
  - Method 1: Annualised AEU = AEU / 25 weeks x 52 weeks.
  - Method 2: Annualised AEU = AEU / Predicted EU x 2014 Actual Use.

(e) Separately calculate CHP Primary Energy Savings using the CER CHP Primary Energy Savings calculator spreadsheet.

Baseline & Reporting Period Energy Use

	Baseline Period (5 Jan.- 28 Dec. 2014)	Baseline Period (27 Apr. – 19 Oct. 2014)	Reporting Period (26 Apr. – 18 Oct. 2015)
Utility Elec. kWh	1,806,750	866,250	464,563
CHP Elec. kWh	-	-	337,500
Utility Gas kWh	2,130,555	902,450	1,078,125
CHP Gas Use kWh	-	-	843,750

Calculations of Savings

	Electricity	kWh
a	Baseline Period Electricity Use (based on matching dates)	866,250
b	Predicted Facility Electricity Use (a adjusted to reporting period conditions)	909,563
c	Reporting Period Utility Electricity Use	464,563
d	Reporting Period CHP Electrical Output	337,500
e	Reporting Period Facility Electricity Use (c + d, compare with a and b)	802,063
f	Reporting Period Avoided Electricity Use (b – e)	107,500
g	Annualised Avoided Electricity Use (more conservative outcome of 2 methods)	213,537
h	Annualised Avoided Electricity Use in Primary Energy (g x 2.5)	533,844
	Gas	**kWh**
a	Baseline Period Gas Use(based on matching dates)	902,450
b	Predicted Hotel Gas Use (a adjusted to reporting period conditions)	812,205
c	Reporting Period Gas Use	1,078,125
d	Reporting Period CHP Gas Use	843,750
e	Reporting Period CHP Heat **Used/Consumed**	306,000
f	Baseline Period Boiler Seasonal Efficiency	70%
g	Reporting Period Avoided Boiler Gas (e / f)	437,143
h	Reporting Period Facility Gas Use (c – d + g)	671,518
i	Reporting Period Avoided Gas Use During (b – h)	140,687
j	Annualised Avoided Gas Use (more conservative outcome of 2 methods)	292,629
	Annualised Avoided Gas Use in Primary Energy (g x 1.0)	292,629
	CHP	**kWh**
a	Reporting Period Gas Use (based on **NCV** of fuel)	843,750
b	Reporting Period Electricity Generated	337,500
c	Reporting Period Heat **Used/Consumed**	306,000
d	Electrical Efficiency (b / a)	40.0%
e	Thermal Efficiency (c / a)	36.3%
f	Primary Energy Saved % (From CER calculator)	21.81%
g	Reporting Period Primary Energy Saved	183,997
h	Annualised Primary Energy Saved	382,714
i	Annualised Secondary Electricity Savings [(d/(d+e)*h)/2.5]	80,290
j	Annualised Secondary Gas Savings [(e/(d+e)*h)/1]	181,990

The below table summarises the savings as calculated in the above table.

	Secondary Energy (kWh)		Primary Energy
EEIM	Electricity	Gas	kWh
Boiler and Lighting Upgrade	213,537	292,629	826,473
CHP	80,290	181,990	382,714
Total	**293,827**	**474,619**	**1,209,187**

Other Observations

These savings figures are Preliminary but based on a good amount of operational data (25 weeks). However, as the operating performance of the system has not been tested through a cold season. This will affect the annual savings figure in the following ways;

1: The new boilers have been operating during shoulder months to provide space heating (the CHP provides the baseload DHW requirements in the summer with some top up from the boilers) and as they are modulating condensing units they operate at a higher efficiency at these times. During winter operation they will be operating at higher temperatures, reducing their ability to condense and thus reducing efficiency.
2: The CHP dumped approximately 20% of its heat output during the summer months. The amount of heat being dumped will reduce during the winter and so its efficiency will improve.

The improved heat uptake from the CHP should offset the reduction in boiler efficiency so the savings figure stated is deemed to be conservative.

The savings being seen here are expected to persist into the future. The facility has invested in new equipment and plans to expand its operations are underway.

Appendix B – Calorific Values of Fuel

When converting fuel use to kWh it is essential to consistently use the gross calorific value. When reporting final energy savings in the NREC form the conversion factor provided assumes the final energy savings are in gross calorific terms.

Networked Natural Gas

For networked natural gas, the calorific value of gas varies depending on the quality of the gas in the grid at the time of use, and on pressure and temperature at the point of connection. The correct value to use is displayed on the gas invoice provided by the utility company.

When evaluating annual consumption for a project, and monthly gas volumes for a sub-meter are being used, the M&V practitioner should use the CV values supplied on the monthly invoices to convert gas volumes to energy rather than using an average annual CV figure.

Alternatively, one may use the conservative default value in Table B.1 below.

Other Fossil Fuels

If the fuel supplier does not provide a gross CV figure on an invoice then the figures supplied below may be used.

Table B.1

Fuel	Form	Unit of Supply	Gross Cv (kWh/unit)
Coal	Industrial Fines	Tonne	7,759.2
	Standard coal	Tonne	7,900
L.P.G.	Commercial Cylinders	kg	13.96
	Bulk L.P.G.	Litre	7.09
Networked Natural Gas[1]	Grid Supply	m^3	10.42
Oil	Gas Oil	Litre	10.55
	Kerosene	Litre	10.18
	Light Fuel Oil	Litre	11.21
	Medium Fuel Oil	Litre	11.32
	Heavy Fuel Oil	Litre	11.45
Peat	Briquettes, baled	Bale	67
Wood	Fuel Chips (35% moisture)	kg wet	3.2
	Pellets	kg	4.8

Source: SEAI Fuel Cost Comparison report – July 2015 (with the exception of natural gas)

1. This is a conservative figure and where possible/appropriate the CV as stated on the Host gas invoice should be used.

Appendix C – Default Values for Lighting Control Gear Losses

Percentage Increase	Multiplier	Applicable lamp types
0%	1.00	Electronic control gear T8,T5, PL, 2D =, SOX; Induction; LED
5%	1.05	Electro-magnetic Mercury Vapour; SON and Methal Halide > or = 400W
10%	1.10	Electro-magnetic SON and Metal Halide < 400W
15%	1.15	Electro-magnetic T8 and T12
20%	1.20	Electro-magnetic SOX
25%	1.25	Electro-magnetic PL, 2D

Appendix D – ISO50001 M&V Worked Examples

D.1 ISO50001 Synopsis M&V Plan and Report Example – Campus ABC

Whole Facility or SEU Approach

The selected method of analysing the savings for this site is to use the Whole Facility Approach

Whole Facility EnPIs Vs EnB

Measurement Period	Energy				Relevant Variable	Energy Performance Indicator [kWh/sq.m.]	
Year	Electricity [kWh]	Gas [kWh]	DD Corrected Gas	Primary Energy (DD corrected)	TUFA [sq.m.]	Elec	Gas (DD corrected)
2012 Baseline	24,261,904	54,854,528	54,871,758	115,526,517	139,890	173.436	392.249
2013	23,786,180	55,357,781	53,273,552	112,739,002	139,890	170.035	380.825
2014	23,405,754	50,325,255	52,486,258	111,000,643	140,100	167.065	374.634
2015							
2016							
2017							
2018							
2019							
2020							

Identify EEIMs

In general, the ISO 50001 system delivers energy savings by:

- **Building optimisation to take account of seasonal and occupancy related changes**, i.e. the beginning and end of the heating season and changes between teaching term, study-exams periods, and holidays. Optimisation is implemented by (a) adjustment of BMS settings (b) manual adjustments by key staff. Customised checklists have been developed for each building covering BMS and/or manual settings, and these are distributed for completion.
- **Baseload reduction audits**, involving a documented process to analyse electrical load profiles, investigate base loads to identify users, identify opportunities for improvement and then implement associated changes.
- **Behavioural change**, achieved through a targeted energy champion programme and a wider staff and student awareness campaign.
- **Technical reviews and building audits** to identify energy efficiency improvement projects, and the subsequent implementation of these. The 2 main project that occurred in 2014 are;

a) P14.1 - LED lighting project in the Arts Building. This project consisted of the replacement of 950 no. 4 x 18W T8 fittings with 34W LED panels, with no change to controls.

b) P14.2 - LED lighting project in Physics. This project consisted of the replacement of 650 no. twin 58W T8 lamps with 2 x 34W LED tubes (removing control gear from the fitting), and occupancy-daylight switching. Original hours were 3,200 p.a. and 20% savings from occupancy and daylight linking have been estimated based on observations of the various areas.

Engineering Calculations

Engineering calculations for the 2 specific projects as identified above can be seen below;

P14.1 - Arts Building LED Light Fitting Replacement													
Status	Fitting Type	Areas of Use	Load					Hours				Electricity	Notes
			Fitting W	Ballast losses	Lamp load per fitting Watts	No. Fittings	Load kW	Switched	Control Factor	Total Hours	kWh p.a.	
Pre EEIM	4 x 18W T8 fitting with electro-magnetic control gear	Lecture Theatres, teaching spaces and common areas	72.0	15%	82.8	950	78.7	3000	1	3000	235,980	
Post EEIM	34 W LED Panel	See above	34.0	0%	34	950	32.3	3000	1	3000	96,900	
										Saving	139,080	

P14.2 - Physics LED Light Fitting Replacement													
Status	Fitting Type	Areas of Use	Load					Hours				Electricity	Notes
			Fitting W	Ballast losses	Lamp load per fitting Watts	No. Fittings	Load kW	Switched	Control Factor	Total Hours	kWh p.a.	
Pre EEIM	2 x 58W T8 fitting with electro-magnetic control gear	Labs and teaching areas	116.0	15%	133.4	650	86.7	3200	1	3200	277,472	
Post EEIM	2x34W LED tube equivalent	See above	68.0	0%	68	650	44.2	3200	0.8	2560	113,152	Control gear removed and fittings retained
										Saving	164,320	

There are however other savings which occurred during the year due to other measures taken as described previously.

Calculations of the overall annual savings which occurred can be seen as follows;

2. Calculation of Energy Performance Related Savings

Adjusted Baseline Energy			
	Electricity	Gas	Unit
Baseline En.PI	173.436	392.249	kWh/m2
Reporting Period TUFA	140,100	140,100	m2
Adj. Baseline Energy	24,298,325	54,954,131	kWh

Avoided Energy Use			
	Electricity	Gas	Unit
Adj. Baseline Energy	24,298,325	54,954,131	kWh
Reporting Period Energy	23,405,754	52,486,258	kWh
Avoided Energy Use	892,571	2,467,873	kWh

3. Calculation of 2014 Savings (Credits)

	Electricity	Gas	Unit
Avoided Energy Use	892,571	2,467,873	kWh
Less 2013 Savings Claimed	475,724	1,598,207	kWh
2014 Energy Savings	**416,847**	**869,666**	**kWh**
Primary Energy Savings		**1,911,785**	**kWh**

4. Distribution of Savings

2014 Energy Savings	1,911,785	kWh	
2014 Project Savings (Calc.)	758,500	kWh (see note)	40%
Savings from other EEIMs	1,153,285	kWh	60%

Note: project savings may only have applied for part of year, but calc is for annual savings

Explanation of Gap Between Calculated or Verified Savings and Whole Facility Use

From Box no.4 above it can be seen that the 2 specific projects that were implemented account for 40% of the overall savings on the site. The remaining 60% have occurred on account of several optimisation and baseload reduction activities which have occurred throughout the year. This, in conjunction with the awareness campaigns which have been run on the campus and energy monitoring and management must account for the remainder of the savings being achieved.

Please indicate who the project coordinator was on the project.	**Energy Supplier** ☐ **Other** ☐ **Client Organisation** ✔

D.2 ISO50001 NREC Application Example

This form is to be completed by Energy Suppliers seeking to claim credits for energy savings initiatives in the non-residential sector in fulfilment of its energy savings target as envisioned under Directive 2012/27/EU on Energy Efficiency and S.I. 131 of 2014 European Union (Energy Efficiency Obligation) Regulations. SEAI shall preserve the integrity and confidentiality of all information provided by Energy Suppliers and their clients in this form.

Section 1 Party Details.

Table 1a is to be completed by the Energy Supply Company.

1a. Energy Supplier Details

Energy Supplier	Power Ltd		
Contact Name	Alan Smith		
Position	Manager		
Address	12 High Street		
	Blackpool		
	Dublin		
Telephone	01 784 2864	**Mobile**	
Email	asmith@power.ie		

The Client Organisation (1b) is the party who has had an energy saving measures installed, while the energy savings credits are awarded to the Energy Supplier.

1b. Client Organisation Details

Client Organisation	Campus ABC		
Contact Name	John Cummins		
Position	Facilities Manager		
Address	Glen Curragh		
	Bishopstown		
	Cork		
Telephone	023 521 3758	**Mobile**	
Email	jcummins@campusabc.ie		

1c. External Project Coordinator (where applicable)

Project Coordinating Company			
Principal Business Activity			
Contact Name			
Position			
Address			
Telephone		**Mobile**	
Email			

Section 2: Project Details. In this section enough information on the project should be provided to allow appropriate assessment of the project and its savings. If the project has received financial assistance from SEAI in the form of grant or funding only section 2a needs to be completed.

2a. Nature of Project

Was the project a cluster/group project in partnership with other Client Organisations?	**Yes** ☐ **No** ✔
If Yes, state who the other Client Organisations are and submit in an Appendix	

2b. Project Summary

Main Project Title	Campus ABC ISO50001 Annual Savings 2014	
Number of Sub-Projects	2	
Select Project Type/s.	**Building Upgrades** ☐ **Public Lighting Upgrades** ☐	**Transport Upgrades** ☐ **Other (Please Describe)** ✔
Other (Please Describe)		
Campus ABC implemented ISO50001 in 2012 and received independent certification in January 2013. This NREC application is for energy savings achieved in 2014 relative to the 2012 baseline, but excluding energy savings already achieved and claimed in 2013.		

The scope of the ISO50001 system is electricity use in the main campus. In 2014, this encompassed 140,100 m^2. (TUFA) of mixed use buildings spread over 60 different buildings.

The Significant Energy Users are 30 key buildings which account for 75% of energy use; these are identified in Section 2c.

In general, the ISO 50001 system delivers energy savings by:

- **Building optimisation to take account of seasonal and occupancy related changes**, i.e. the beginning and end of the heating season and changes between teaching term, study-exams periods, and holidays. Optimisation is implemented by (a) adjustment of BMS settings (b) manual adjustments by key staff. Customised checklists have been developed for each building covering BMS and/or manual settings, and these are distributed for completion.
- **Baseload reduction audits**, involving a documented process to analyse electrical load profiles, investigate base loads to identify users, identify opportunities for improvement and then implement associated changes.
- **Behavioural change**, achieved through a targeted energy champion programme and a wider staff and student awareness campaign.
- **Technical reviews and building audits** to identify energy efficiency improvement projects, and the subsequent implementation of these.

2c. Building Details

In the case of projects for upgrading a building or set of buildings, please specify the gross floor area of the building/s and of the part of the building/s to which the proposed works apply. If there is a pre-existing Building Energy Rating (BER) or Display Energy Certificate (DEC), please provide the certificate number/s.

Building / Facility Name	Address	Address Line 2	Address Line 3	County	Gross floor area (m^2)	Use e.g. office, school, hospital	Choose between BER DEC Not available	Rating	Certificate Number
This has been left blank as this is a fictional example. All of the buildings identified as SEU would have inserted here if this was a real submission – This is to be completed in full in the case of a genuine submission to the SEAI.									

2d. Summary of Energy Efficiency Improvement Measure/s

Summary of EEIM/s

Please provide details of the theory behind how each EEIM will save energy. For example stating that you have installed VSDs on a fan is not sufficient, and you must also describe on what basis you are able to reduce fan speeds and still maintain the required service. Where there are a number of EEIMs, each should be numbered and described separately

In addition to Building Optimisation, Base Load Reduction and Behavioural Change, the following EEIMs where implemented in 2014:

- P14.1 - LED lighting project in the Arts Building, saving 139,080 kWh
- P14.2 - LED lighting project in Physics, saving 164,320 kWh

P14.1 – This project consisted of the replacement of 950 no. 4 x 18W T8 fittings with 34W LED panels, with no change to controls.

P14.2 – This project consisted of the replacement of 650 no. twin 58W T8 lamps with 2 x 34W LED tubes (removing control gear from the fitting), and occupancy-daylight switching. Original hours were 3,200 p.a. and 20% savings from occupancy and daylight linking have been estimated based on observations of the various areas.

2e. M&V or Engineering Calculations?

M&V or Engineering Calculations*?*

Please confirm if this application has used M&V or Engineering Calculations to establish energy savings.

If an OP has concluded that this application is deemed suitable for derogation from performing M&V then this must be stated, along with a description on how this decision has been made. E.g. According to the derogation decision tree, the number of NREC applications requiring M&V within this energy savings band has already been satisfied.

If this application has been selected for M&V, then list which sub-projects have used M&V and which have used Engineering Calculations.

The NREC application – Campus ABC ISO50001 2014 – involves the M&V of performance. The whole facility approach for ISO50001 is being adopted.

This approach also requires either M&V or engineering calculations of projects. Engineering calculations are provided for Project P14.1 and P14.2.

See attached Synopsis M&V Report for 2014 which outlines Campus ABCs performance improvement and calculation of savings claimed in 2014.

2f. Project Timeline

Project Start Date	1 January 2014
Project Completion Date	31 December 2014
Please note that if any project is undergoing full M&V the project must be fully completed and commissioned prior to the start of the reporting period.	

2g. Engineering Calculation Summary

Engineering Calculations Summary

Where engineering calculations have been performed, a summary of the key data inputs, assumptions made and calculation steps must be displayed here. A table showing the calculation steps and final outputs from a spreadsheet with some commentary would suffice.

Where M&V has been performed, a synopsis Plan and final/preliminary Report must submitted as an appendix with this application. A template can be found under section 6 of the SEAI 'Guidance on authenticating and claiming energy credits' document.

Where multiple sub-projects are concerned these, calculations should be shown separately and numbered as per section 2d.

P14.1 - Arts Building LED Light Fitting Replacement

Status	Fitting Type	Areas of Use	Load					Hours			Electricity	Notes
			Fitting W	Ballast losses	Lamp load per fitting Watts	No. Fittings	Load kW	Switched	Control Factor	Total Hours	kWh p.a.	
Pre EEIM	4 x 18W T8 fitting with electro-magnetic control gear	Lecture Theatres, teaching spaces and common areas	72.0	15%	82.8	950	78.7	3000	1	3000	235,980	
Post EEIM	34 W LED Panel	See above	34.0	0%	34	950	32.3	3000	1	3000	96,900	
										Saving	139,080	

P14.2 - Physics LED Light Fitting Replacement

Status	Fitting Type	Areas of Use	Load					Hours			Electricity	Notes
			Fitting W	Ballast losses	Lamp load per fitting Watts	No. Fittings	Load kW	Switched	Control Factor	Total Hours	kWh p.a.	
Pre EEIM	2 x 58W T8 fitting with electro-magnetic control gear	Labs and teaching areas	116.0	15%	133.4	650	86.7	3200	1	3200	277,472	
Post EEIM	2x34W LED tube equivalent	See above	68.0	0%	68	650	44.2	3200	0.8	2560	113,152	Control gear removed and fittings retained
										Saving	164,320	

2h. Evidence of Project Implementation

Evidence of Project Implementation

The OP must satisfy themselves that any project or sub-project included in this submission for energy credits has actually occurred and is generating the stated savings. Evidence can be provided in many forms such as before and after photos, copies of paid invoices or a statement that a representative from the OP company has visited site and witnessed the operation of the finished project. Details of what evidence is available in case of audit by SEAI must be included here.

The ISO50001 system maintains documents and records of energy management activities including building optimisation, base load assessments and energy audits.

P14.1 – Photos of original and new installation in sample locations are available. This includes photos of the original lamps, their wattage and the electromagnetic control gear for a typical fitting. A data sheet is available providing specification of the new fitting.

P14.2 - Photos of original and new installation in sample locations are available. This includes photos of the original lamps, their wattage and the electromagnetic control gear for a typical fitting. A data sheet is available providing specification of the new lamps. Supplier invoice identifies the quantity of fittings supplied.

Section 3: Annual Savings from project.

3a. Annual Energy Savings

Enter the current annual energy consumption at the project measurement boundary (in kWh and in €) and estimate the annual energy savings benefits (in kWh, € and kg of CO_2) directly attributable to the project. Where there is more than one building, facility or EEIM involved in the application, please enter the aggregate figures. Present the current consumption and savings figures for the different energy forms shown below in secondary energy and convert the savings to primary energy using the conversion factors provided.

Energy Form	Current Annual Consumption at Measurement Boundary		Annual Energy Savings Directly Attributable to the Project				
	kWh (Gross Cv)	Euro (excl. VAT)	kWh (Gross Cv)	Euro (excl. VAT)	kg CO_2	Primary Energy Saving	PEE Factor
Electricity	23,405,754	€3,744,921	416,847	€66,696	242,522	1,042,119	**2.5**
Thermal	52,486,258	€2,099,450	869,666	€34,787	172,194	869,666	**1**
Fleet (vehicles)							**1**
Total	75,892,012	€5,844,371	1,286,514	€101,482	414,716	1,911,785	

3b. Savings Attributable by EEIM

Enter the estimated energy savings benefits of each EEIM being performed in the project ***(extend table where necessary)***

EEIM	Primary Energy Savings kWh	Euro €	kg Co_2
Project Savings: P14.1 and P14.2	758,500	€48,544	176,518
Energy management savings: Building optimisation, baseload reduction, behavioural change	1,153,285	€52,938	238,198
Totals	1,911,785	€101,482	414,716

3c. Materiality of contribution by Obligated Party to savings achieved

Overview of Contribution by the OP and why it is deemed to be material to the project.

Describe the contribution by the OP which has enabled the project to proceed. Please note that unless OP's clearly explain how they are material to energy savings achieved, no energy credits can be awarded. It is therefore imperative that appropriate information is given to substantiate the materiality of their contribution.

Power Ltd provides ongoing assistance to Campus ABC by providing them with resources to help identify opportunities in the form of audits and feasibility studies. This has resulted in the identification of the 2no. lighting projects which were implemented this year and a series of other operational changes.

Power Ltd has also contributed to awareness campaigns and has developed materials which were used for circulation to students.

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4. Declaration of Client Organisation

Client organisation statement of materiality of Energy Supplier's Contribution. Please provide details of how the OP's contribution enabled the project to proceed.
Without the aid of Power Ltd these EEIMs would not have been identified and therefore would not have been implemented. Campus ABC does not have in-house technical capabilities so their assistance proved to be extremely valuable.

- I hereby declare that the information provided in respect of this application is to the best of my knowledge correct. I am duly authorised to sign on behalf of the client organisation(s).
- I agree to allow SEAI or its delegated agent(s) to verify any of the technical information contained herein which is reasonably available.
- I confirm that the Energy Supplier indicated in this form has been involved in the execution of this project and has been material to the achievement of the claimed savings.
- I confirm that the Energy Supplier should be awarded the indicated energy savings from this project.

Signature on behalf of Client Organisation	xxxxxxxxxxx
Name (Capitals)	John Cummins
Position	Facilities Manager
Date	13th of February 2015
Email	jcummins@campusabc.ie
Phone Number	023 521 3758