Department of Energy & Climate Change

Electricity Demand Reduction Pilot

Measurement and Verification Manual

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www.eevs.co.uk

Any enquiries regarding this publication should be sent to us at edr-project@decc.gsi.gov.uk

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1. Introduction

1.1. What is in this manual?

- An introduction to Measurement and Verification (M&V).
- Guidance on how to complete a robust M&V Plan. This will form part of the application pack you will need to submit in October 2014 to clear the pre-qualification process to enable participation in the EDR auction in January 2015.
- Guidance on the reporting and evidence that will be required post auction (for successful bidders) in order to receive EDR payments.

How this manual is structured

This manual is organised in the order in which you should carry out M&V activities and is divided into three main chapters:

Chapter 1: Introduction

Chapter 1 provides an overview of the information you have to provide and a timetable of key M&V activities.

Chapter 2: Completing Your M&V Plan

Chapter 2 gives an overview of the M&V Plan and then describes all the information required to complete the plan. Some sections of the M&V Plan require simple information about your organisation and the type of project you are proposing; others require more complex data and evidence. The guidance is tailored to provide additional detail and information where necessary and signpost participants to worked examples to aid completion of the required elements.

Chapter 3: Post Auction Activities

Chapter 3 describes the M&V requirements for participants who have been successful in the EDR Auction. It covers reporting, Operational Verification (OV) and the evidence you will need to submit. The data submitted via the guidance in this section will determine your payment.

Under each chapter there are a number of sub-sections:

Section Overview	Each section starts with a “Section Overview” box outlining what is covered.
M&V completion steps	At appropriate points there are “M&V Plan Completion Steps” boxes giving step by step guidance for completing the relevant tab(s) of the M&V Plan.
End of section checklist	At the end of each section there is a “End of section checklist” box to show all the activities that should have been completed.
Examples & Case Studies	Examples and Case Studies are in blue boxes.
Definitions	Definitions are in purple boxes.

One page ‘end of section summaries’ are also included for the main sections of the M&V Plan Template.

Evidence requirements are detailed where applicable. For an overall view of required evidence see Appendix A: Evidence Summary.

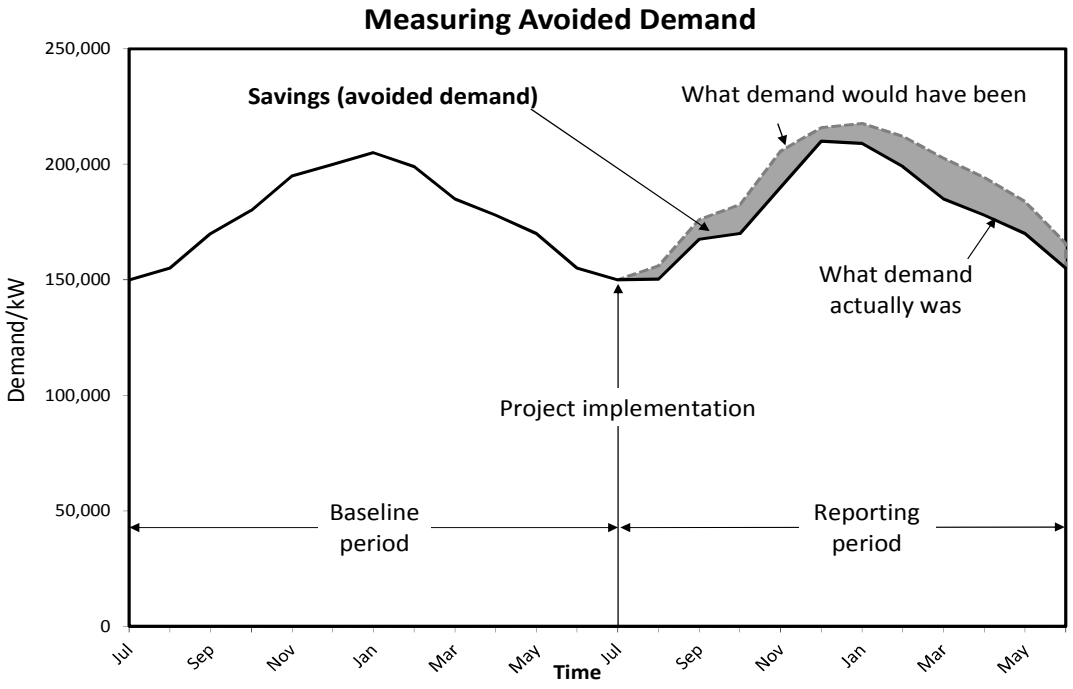
What you should have done before you continue to read this Manual

The EDR pilot is open to a large number of projects and technologies, however there are some exceptions. Before continuing through this manual you should ensure you have read section one of the participant handbook and confirmed that your project is eligible to participate in the pilot.

One of the eligibility criteria is that sites included in a project must have a payback period of 2 years or longer. The data to back this up will be collected via your M&V Plan and the guidance for this is covered in section 2.2 ‘Site payback’ of this manual.

1.2. Introduction to Measurement & Verification

Measurement & Verification (M&V) is the process of using measurements to reliably determine savings achieved by an energy efficiency project. Savings cannot be directly measured because they represent the absence of electricity use. Instead, savings are calculated by comparing electricity use before and after a project, whilst making appropriate adjustments as shown below.



Participants wishing to bid into the pilot will need to provide an M&V Plan. This is a document that sets out the expected savings of your Electricity Demand Reduction (EDR) project and how the savings will be determined.

The process described in this manual for completing a measurement & verification plan is guided by the International Performance Measurement & Verification Protocol (IPMVP). The IPMVP is a guidance document describing common practices in measuring and reporting savings achieved by energy efficiency projects at end-user facilities. It provides methods to evaluate savings and specifies the contents of an M&V Plan.

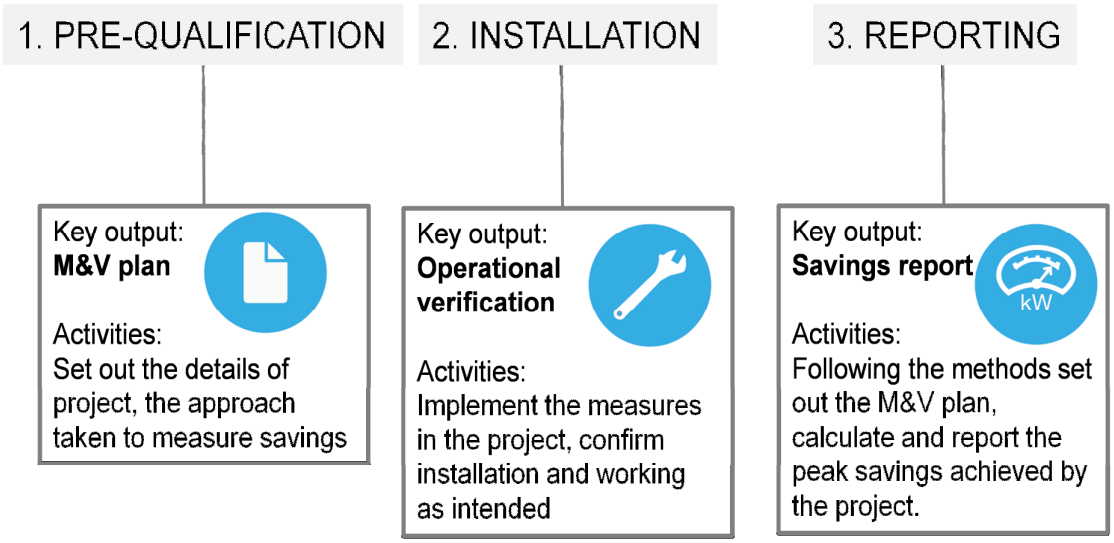
There are four methods that you can use to measure and verify savings in the pilot. These are:

- **Deemed savings** – for simple projects involving a swap of one product for a more efficient version that are on the deemed list (see below) participants can use 'deemed savings'. Under this approach spreadsheets are used to calculate savings with details of both the existing and replacement technologies supplied by the participant. Appendix B provides more details on deemed technologies. Only technologies on the list can be deemed, as follows:
    - Lighting
    - Lighting controls
    - Motors & Variable Speed Drives (VSDs)
    - Process Chillers
    - Heating controls
    - Retail Display Cabinets (RDCs)
    - Professional Refrigerated Storage Cabinets (PRSC)
- **Three metered approaches** – for more complex projects involving multiple electricity-saving measures, industrial processes, or technologies not covered by the deemed savings list or where actual measurements of savings are required you can

select one of three methods involving the use of electricity meters. These are all based on the International Performance Measurement & Verification Protocol (IPMVP), these are:

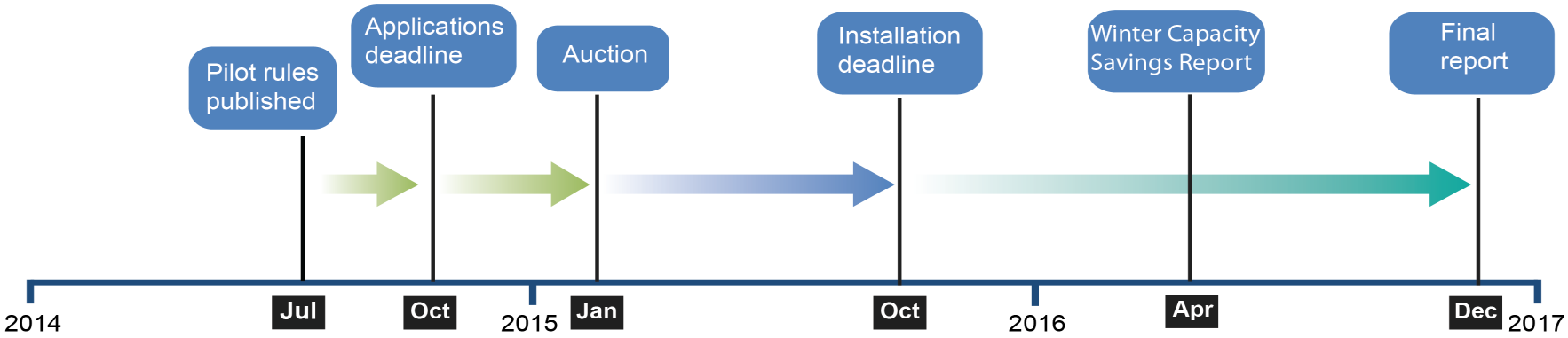
- Partial measurement
- Full measurement: Submetering
- Full measurement: Total Building Electricity

Measurement and Verification involves three core activities, as set out below.



A high level pilot timetable including key M&V milestones is provided on the next page.

PILOT TIMELINE: KEY MILESTONES & M&V ACTIVITIES



Applications prepared & submitted

Applications checked, eligible projects submit bids (£/kW) for savings

Prepare and submit M&V plan using M&V manual:

- Check eligibility
- Calculate total and peak savings for project
- Choose M&V method(s)
- Provide project information (size, location etc)
- Define baseline and reporting period
- Collect baseline data and other evidence
- Set out operational verification and reporting activities and timings

Successful Bidders Install Equipment

Operational Verification

- Confirm equipment installed and operating as intended e.g:
- Invoices confirming installation
- Visual inspection Measurements from a sample of installations
- Following manufacturer's/supplier commissioning procedure.

Savings are measured and verified, savings reports submitted

Measure and report savings:

- Demand readings taken during the reporting period
- Details of independent variables that affect demand (where relevant)
- Details of any corrections or changes that have applied to the data along with justifications for any changes

1.3. Introduction to the M&V Plan

Section Overview

This section provides an overview of the information you need to include in your M&V Plan. Subsequent sections provide more detailed guidance on filling out specific sections of the M&V Plan.

You will need to submit your M&V Plan alongside your application by the 31st October 2014 in order to participate in the pilot (see the participant handbook for more detail).

An M&V Plan is a document that details the M&V methods and techniques that you are using to determine the savings resulting from the installation of more efficient electrical equipment. Your M&V Plan may cover multiple technologies and should be submitted alongside other documents required for participation in the pilot by 31 October 2014.

In addition to using accurate and conservative methods to calculate the savings, a good M&V Plan is clear, consistent, and repeatable. All the assumptions, procedures, and data for the M&V Plan should be recorded properly so that they may be easily referenced and checked by others. The data included should be sufficient for a third party to audit the M&V procedures and verify the savings and content of the plan.

An M&V Plan submitted to the EDR auction must include:

- Information about the project including details of the demand reduction measures being installed, expected savings, time of use over the winter peak period etc.
- The M&V method(s) that will be used to measure the savings from the project
- Details of the baseline and descriptions of any variables that affect the project's electrical demand (such as outside temperature, time of day, process changes, occupancy, etc.) that will be measured or monitored and used in the calculation of savings.
- Confirmation that accuracy is sufficient for measurement of savings and sample size is sufficient (where used)
- Operational verification and reporting activities that will be carried out to confirm installation and report savings.
- Supporting evidence as set out in this manual.

An **'M&V Plan Template'** in excel format is provided. You should use this to provide information about your project. M&V Plans in any other format will not be accepted. In addition you will need to provide additional supplementary evidence where indicated in this manual. Evidence requirements are summarised below.

Your M&V Plan must be saved with the naming convention Application ID, M&V Plan, date e.g. GHTT0708-876 M&V Plan 030515

1.4. Summary of evidence requirements

Participants will be required to provide evidence to substantiate information provided in their M&V Plan. Failure to provide the required evidence will mean projects will not be able to participate in the auction. You should append the required evidence to your M&V Plan using the naming conventions set out in this manual (see below).

The evidence that you will need to provide is as follows:

- **Site payback evidence**: participants will need to demonstrate that the overall payback of measures installed at each site in their project is greater than 2 years.
- **Evidence of kW saving estimates**: the calculations and associated evidence (e.g. supplier audits, equipment specification etc.) underpinning the kW estimates of savings broken down for each technology type included in a project.
- **Operational Verification evidence**: for each technology type included in a project participants will be required to supply details of Operational Verification procedures that will be carried out to ensure the equipment is properly installed and operating as intended.
- **Baseline and reporting data**: participants using M&V approaches involving the use of metering will be required to provide baseline and reporting data for each measurement boundary included in their project. They will also have to supply data relating to any variables that are used to adjust the baseline.

In addition, participants may be asked to provide evidence to substantiate the **peak-relevance** of the technologies included their project.

More information on evidence requirements are contained in the relevant sections of this manual. A summary of evidence requirements is included in Appendix A and an evidence reference checklist is included in the cover sheet of the M&V Plan Template.

Where possible it would be preferable if you could consolidate your evidence submissions e.g. putting all the site payback evidence into one file with a coversheet that references the evidence would be preferable to avoid too many attachments.

1.4.1. Naming Convention for files that form part of your M&V submission

You must ensure that for any files submitted as part of your M&V Plan you use the following naming convention:

Application ID, record category, description of file, ddmmyy

Application ID: You will be allocated an Application ID by DECC at the start of the application process. This will be in the form of your Participant ID (4 letters and 4 numbers – provided on submission of your Expression of Interest) followed by three numbers e.g. GHTT0708-876

Record Category: You must select one of the following categories:

- M&V Plan
- Deemed Calculator
- Site Payback
- kW saving
- OV
- Baseline
- Reporting

If you need to attach a file that does not fit into any of the above categories please create a clear concise category name for your submission.

Description of file: You should describe the information you are submitting clearly and concisely. See examples for each Record Category below:

Record Category	Description of file
M&V Plan	No description is required as you should only have one M&V Plan per application.
Deemed Calculator	Please use the technology of the calculator you have used e.g. Lighting Controls, PRSCs etc. See Appendix B.
Site Payback	Please describe the evidence you are submitting to support your site payback calculation e.g. supplier quote. See section 2.2.
kW saving	Please describe the evidence you are submitting to support your kW savings estimates e.g. supplier audit. See section 2.3.
OV	Please describe the evidence you are submitting to detail you're your Operational Verification e.g. motor commissioning procedure. See section 2.4.
Baseline	Please use your Boundary ID for Template Calculation Spreadsheets or your Boundary ID plus "raw data" for raw meter data e.g. B1, B1 raw data etc. See section 2.6.
Reporting	Please use your Boundary ID for Template Calculation Spreadsheets or your Boundary ID plus "raw data" for raw meter data e.g. B1, B1 raw data etc. See section 3.2.

Date: This is for version control, please use the date you are submitting your final version. Please use the format ddmmyy.

Please see example file names below:

- M&V Plan
  e.g. GHTT0708-876 M&V Plan 030515
- Deemed Calculator
  e.g. GHTT0708-876 Deemed Calculator Lighting Controls 030515
- Site Payback
  e.g. GHTT0708-876 Site Payback supplier quotes 030515
- kW saving
  e.g. GHTT0708-876 kW saving supplier audit 030515
- OV
  e.g. GHTT0708-876 OV motor commissioning procedure 030515
- Baseline
  e.g. GHTT0708-876 Baseline B2 030515
- Reporting
  e.g. GHTT0708-876 Reporting B2 030515

1.5. Structure of this manual

The manual is structured so that it mirrors the order in which you need to complete the M&V template. It contains the following eight main sections, as shown below.

Completing the M&V Plan

1. Contact Information - Information you will need to supply about the relevant individual(s) involved in measuring and verifying savings of your project.

2. Site Payback - You will need to supply information to confirm that each individual site included in your projects has a payback period of greater than 2 years. This section gives an overview of the information and evidence you have to provide.

3. Project detail and peak saving - This section provides guidance on the more detailed information you need to provide about your project including the technologies included in your bid and their time of use. You must use this section of the template to record the total expected average kW saving over the peak period of your project.

4. Operational Verification - In this section you will set out the activities you will undertake to confirm installation of the measures included in your project and that they are operating as intended. Correct installation and configuration of equipment helps to ensure the measures included in your project deliver the expected savings.

5. M&V Approach and Boundary - In this part of the template you will set out the M&V approach(es) and the associated measurement boundaries used to measure the savings of your project. Given the 100kW minimum project size it may be that you need to use more than one M&V approach or boundary to measure the savings from your project.

6. Baseline - for all metered approaches savings are calculated with reference to a baseline. In this section of the template you will provide details of your baseline including if any baseline adjustments are required to calculate savings. You will also need to supply actual baseline data.

Post Installation activities

7. Reporting Operational Verification – this section explains the requirements for reporting back on the activities you set out to confirm installation of the measures included in your project and that they are operating as intended.

8. Reporting Savings from Your Project – this section explains the reporting requirements you need to comply with in order to receive final payment for your project.

If you are looking to only use the deemed approach to measure savings of your project then you do not need to complete the activities in the following two sections of this manual and the template:

- **M&V Approach and Boundary** – the M&V Plan Completion Steps in this section are not applicable to deemed, however you may still find it useful to read about the available approaches.
- **Baseline** – there is no baseline requirement for Deemed Savings

The next chapter provides the guidance for filling out the relevant sections of the M&V template for your project. You should consult the relevant sections of this manual as you fill out the M&V Plan Template.

2. Completing the M&V Plan

2.1. Contact Information

Section overview

This section provides guidance relevant to filling out the following tabs in the M&V template:

- 'Contact information'

M&V plan completion steps

In the "Contact Information" tab of the M&V Plan Template:

- For the **Project Lead** section you should complete all the blue boxes with the details of the person in your organisation that is leading the project and will be the main contact for correspondence.
- For the **M&V Responsibilities** Section you should complete all the blue boxes with the details of the lead person who has prepared the M&V Plan; they can be an individual from your organisation, technology supplier or a third party.
- For the **Installation Responsibilities** section you should complete all the boxes with the details of the person who is responsible for co-ordinating the installation of the equipment. They may be someone from your organisation, a representative of the supplier or a third party.

End of section checklist

By the end of this section, you should have:

- Completed the 'Contact Information' Tab

2.2. Site payback

Section Overview

You will need to supply information to confirm that each individual site included in your project has a payback period of two years or longer. This section gives an overview of the information and evidence you have to provide.

It provides guidance relevant to filling out the following tabs in the M&V template:

- 'Site payback'

There are a number of eligibility criteria that all projects must meet in order to participate in the EDR Pilot. For more detail on these criteria please check section one of the participant handbook. One of these requirements is that the measures included within **each individual site** included in a project must have an overall "payback" period of two years or more.

Site

A site is an area of land falling within a continuous boundary which encloses the land used in connection with the operation of an EDR measure. For this purpose, however, an area of land may still be regarded as a single site even if it is dissected by a road, railway line or river. Other non-contiguous parcels of land would not, however, constitute a single site.

Payback is a calculation which is used to work out how long an investment takes to pay for itself. For example, if the total cost of equipment installed at a site is £12,000 and the annual savings from avoided electricity consumption at the site is £3,000 the payback period would be 4 years.

$$\text{Payback} = \frac{\text{total cost of measures installed at the site}}{\text{annual £ savings at the site}}$$

e.g. £12,000 cost / £3,000 annual savings = 4 years

Working out payback requires two pieces of information:

- the costs associated with the measures installed at each site (includes equipment, delivery and installation costs) – see evidence requirements below.
- the annual savings associated with the efficiency measures installed at each site (the £ savings related to avoided electricity consumption) – see evidence requirements below.

2.2.1. Eligible costs and savings

Only certain types of costs and savings can be used to calculate payback. Eligible costs include:

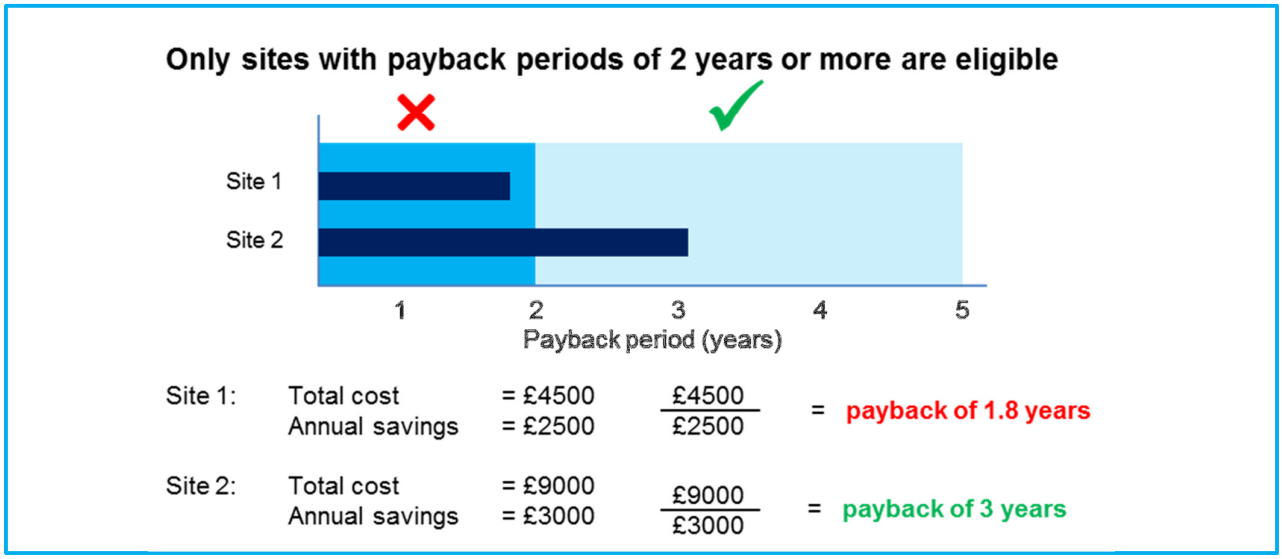
- capital cost of the equipment (i.e. the purchase cost)

- installation costs (e.g. for an engineer to install the equipment)
- delivery costs

All other costs (e.g. from shutting a plant down or those incurred measuring and verifying savings) are not eligible for the purposes of calculating payback.

Eligible savings are the annual monetary savings derived from reduced electricity consumption. The diagram below illustrates the process for calculating payback. The example shows that site 1 would not meet the 2 year payback threshold (a payback period of 1.8 years) but site 2 would (payback of 3 years).

You will need to provide data in the M&V Plan Template for each site included in your bid including total costs and expected savings for the site payback calculation. In terms of evidence you will have to provide a more detailed breakdown by costs and savings by technology type at each site. This is so that if your project alters or is rationed as part of the auction process it is possible to check that the sites included meet the payback threshold.



M&V plan completion steps

In the “Site payback” tab:

Enter the following details into the table for each site of your project (please see the definition of a site above):

- Site Code – should follow the format S1, S2, S3 etc. for as many sites as are included in your project
- Site Address – should be in the format Address line 1, Postcode
- Site Summary – describe your project in terms of the different technologies included and the quantity of each per site. E.g. 100 XXX
- Site Costs (£) - for each of the Hardware, Installation and Delivery columns you should enter the total cost (£0.00) for the given site.
- Expected Annual Project kWh Savings (from your own estimates or supplier) – enter the kWh savings estimated per site
- Electricity cost £/kWh– enter the £/kWh for the site based on your most recent utility bill.

2.2.2. Evidence

The information provided in the M&V template provides overall costs and savings of measures for each site in your project. For evidence, you will need to provide a more detailed breakdown of costs and savings by technology type at each site included in the project.

For example, if site A involves the installation of pumps, motors and lighting the template entry would be a single line for the total costs and savings of all measures at site A. The evidence required for site A would be a breakdown of the total cost and savings for each technology type at the site i.e. calculations covering the costs and savings separately for the pumps, motors and lighting that underpin the total savings figures given in the template. This needs to be provided for each site included in your project. The payback of individual measures installed at a site can be less than 2 years providing the overall payback period of all measures installed at the site are 2 years or longer.

Data	Example Evidence
Details of Project Costs	You will need to provide a breakdown by technology group of costs per site. This could be supplier quotes/invoices, manufacturers’ listed prices sheets etc.
Details kWh Savings	Calculations underpinning kWh savings estimates by technology type, supplier audit from site visit etc.
Details of £/kWh tariff	An electricity bill dated within the last 6 months

Please ensure that for all evidence files you follow the naming convention:

Application ID, record category, description of file, ddmmyy

e.g. **GHTT0708-876 site payback kWh saving estimates 030515**

e.g. **GHTT0708-876 site payback site cost breakdown 030515**

Where possible it would be preferable if you could consolidate your evidence submissions e.g. putting all the site payback evidence into one file with a coversheet that references the evidence would be preferable to avoid too many attachments.

☑ **End of Section Checklist**

By the end of this section, you should have:

- Confirmed that each site included in your project has a payback period of 2 years or greater.
- Completed the site payback tab
- Appended and referenced the required evidence to support your assessment of payback for sites included in your bid as set out above.

Section summary: site payback

REQUIREMENT

You are required to demonstrate that the overall payback period of measures included at each individual site in your project is greater than 2 years.

DESCRIPTION

Payback is a measure of how long an investment takes to 'pay for itself'. It is calculated by taking the total costs of efficiency measures that are installed (at each site) and dividing this by the annual £ savings from avoided electricity use (at each site) to give an estimate of the length of time for the efficiency measures at each site to payback. Eligible costs and savings are set out below.

ELIGIBLE COSTS & SAVINGS

Eligible costs:
- equipment costs
- installation costs
- delivery costs

(all other costs are ineligible for the purposes of calculating pay-back)

Eligible savings:
- annual kWh savings

WHAT YOU HAVE TO DO

Fill out the 'site payback' tab of the M&V template. This will involve providing the total eligible costs and savings for each site.
For each site included in your bid you will need to provide:
- costs of the equipment
- expected kWh savings
- electricity cost

The evidence you provide will need to breakdown costs and savings *by each individual technology type* at each site (see evidence require-ments below).

EVIDENCE REQUIREMENTS

For each site in your project you will need to provide a breakdown by technology type of eligible costs and savings.

Evidence required must cover:
- costs of equipment installed e.g. invoices/quotes/listed prices for each individual technology type at the site
- estimated kWh savings calculations for each technology type at the site (e.g. time of use and savings)
- electricity price used to calculate savings: an electricity bill dated within the last 6 months.

EXAMPLE

If you had 3 sites and two technology types at each (e.g. pumps and lighting) you will have a total of 3 lines in the template (one for each site) but will provide a breakdown in your evidence of costs and savings for the pumps and lighting at each of the 3 sites.

2.3. Project detail and peak savings

Section Overview

This section:

- provides guidance on how to calculate the average kWs over the peak value that you will submit to the EDR auction. This will be the value that you are committed to deliver to and will be able to claim full payment.

It also provides guidance relevant to filling out the following tabs in the M&V template:

- 'Project detail and peak savings' including:
  - the technology breakdown of your project
  - the operational times
  - the savings expected to be achieved

Please note, for deemed savings projects you only need to complete the expected demand reduction box as peak applicability is calculated in the deemed spreadsheet calculators. The total is then input into the peak applicability spreadsheet. For more information please see Appendix B.

In the 'Project detail and peak saving' tab of the M&V template you will need to supply the details of your project including the technologies included in your project and their time of use. You must use this tab to record the average kW savings of your project over the winter peak period.

2.3.1. Calculating the average kW savings value over the peak period

To participate in the pilot you will need to estimate the savings of your project. The usual 'currency' in which efficiency savings are measured are savings over time (kilowatt hours, kWh). You can use the kWh savings to check your project meets the payback criteria as set out in the previous 'site payback' section. However, as set out in the participant handbook, a key objective of the pilot is to test whether EDR could be delivered as part of the Capacity Market. As such the EDR pilot aims to explore the extent to which it is possible to incentivise demand reduction that is relevant to the winter peak period. This is defined as business days between 1 November 2015 and 29 February 2016 (inclusive), 4pm-8pm.

The key metric of savings, and the format that you will need to measure and report savings for bidding into pilot, is in kiloWatts (kWs) (a measure of power draw at a point in time). Further information on peak relevant savings and the difference between kWhs and kWs is provided in Appendix D - FAQs.

To calculate the average savings over the winter peak of your project you will need to fill out the "Project detail and peak savings" tab in the M&V plan template with the kW saving value attached to all the technology types included in your bid and their time of use. You will need to provide a breakdown of the time of use of your equipment for each site included in your bid. Within each site you will have to provide information broken down for each technology and time of use grouping.

While multiple installations of the same technology types will often have the same time of use and so can be grouped together there may be occasions where the same technology type (e.g.

pumps) may have different hours of use within the same site because it has a different application (e.g. used in different parts of a production process). In such cases the same technology will need to be entered as separate entries according to the time of use grouping (e.g. the different pumps would have different entries with their own time of use).

For each technology and time of use grouping you will need to enter the total number of days over the winter peak period that the technology is operational for (up to a maximum of 83 days) which are the business days between November to February inclusive as well as the hours (between 4-8pm) that the equipment is typically operational for over those days. You will also need to provide a basic description of the time of use for the technology grouping in the spreadsheet (see the template for an example). In the event of an audit or inspection the information provided will be used as a reference to check time of use of the equipment included in the project. To be eligible to participate in the pilot your project will need to deliver an average of at least 100kW of savings over the winter peak period (see the Participant Handbook for more detail).

In addition to providing a breakdown of operational times by technology grouping you are also required to provide an overall summary description of the operational hours of your project in the text box on the same tab.

The average savings figure for each measure is calculated by adjusting the actual capacity savings from that measure by the proportion of winter peak hours that it is active for. A project that delivers an 800kW saving for 3 hours each day for 70 working days during the winter peak would therefore deliver an average capacity saving of:

$$800kW \times \frac{3}{4} hours \times \frac{70}{83} days = 506kW_{av}$$

The template is designed to accommodate scenarios where you have already been supplied with the peak relevant kW savings (e.g. from a supplier) of equipment included in your project as well as if you have the peak kW savings but these have not be adjusted to take account of time of use. In both cases you will still need to complete the number of hours/days that the equipment is operational for (see the template for further details).

2.3.2. Calculating savings bid into the pilot

How overall electricity savings are calculated will depend on various factors, such as the type and complexity of the technologies deployed, how and where they are used. Routes to estimating kW savings for a project can include:

i. Supplier estimates

Energy efficiency technology suppliers often carry out an audit of sites, establishing the existing conditions and equipment, for example by inspection or direct measurements. Savings will be calculated based on the likely reduction in electricity consumption achieved with new equipment, dependent on the nature of the technology. For example if it has a lower power rating, the calculation may be as simple as subtracting new from old, and adjusting for the proportion of peak hours it is relevant for.

ii. Your own calculations

You may also be able to establish the efficiency or rating of your existing equipment by inspection or direct measurement. A comparison with the efficiency or rating of new equipment in combination with an estimate or measurement of time of use would enable you to calculate electricity savings expected for a project. For site types with a specific rather than generic purpose (i.e. production plant rather than a hospital) you may have a good

understanding of the processes and associated opportunities for improvements in electricity efficiency and be able to set out calculations of expected savings.

iii. A combination of the approaches above

You may wish to make use of information provided to you by a technology supplier (such as estimates of kW or kWh savings expected installation of a given product) and calculate savings based on your own understanding of the equipment's use. If you are not certain about likely demand reductions or time of use, a conservative approach to estimating savings may be advisable. Overestimating savings, if it subsequently leads to under-delivery versus the estimate, will result in reductions in payments – see section 8 of the participant handbook for more detail.

As set out in the Participant Handbook, the average savings over the winter peak that are bid into the auction will be the responsibility of the participant to deliver. Information on what happens if the expected savings do not materialise is set out in the participant handbook. As long as the savings from the project deliver at least the average peak saving value across the peak period committed to in the auction then participants will be in line for the full payment, even if the actual time of use varies over the winter peak. However, if participants deliver less than the average value committed to reduced payments would result – see the handbook for more information.

To note that irrespective of the M&V approach you choose you will need monitor the time of use of equipment after it is installed over the winter peak period 2015/16 as you will be asked to confirm actual time of use as part of the Winter Capacity Savings Report (see the reporting section for more information).

You will need to provide evidence underpinning the kW estimates of savings for your project.

2.3.3. Evidence

i. kW savings

You will need to provide evidence for the kW estimates of savings for your bid, this could include:

- Audit results of existing equipment
- Supplier specifications for new equipment
- Direct measurement of existing equipment
- Calculations used to estimate electricity usage and savings
- Time of use estimation, particularly peak relevant usage

Please ensure that for all evidence files you follow the naming convention:

Application ID, kW saving, description of file, ddmmyy

e.g. **GHTT0708-876 kW saving supplier audit 030515**

e.g. **GHTT0708-876 kW saving calculations 030515**

ii. Evidence of peak operating periods

You are not required to provide evidence to substantiate the peak operational periods of your project when you submit your M&V Plan. However, DECC may require evidence of peak applicability from a sample of participants over the period of the pilot. Participants should therefore be ready to provide evidence or further information on the peak operational period of their equipment should DECC request further information. Site inspections will also

provide a route through which the operational period of equipment can be verified (see the participant handbook for more detail on-site inspections).

Evidence that participants could be asked to provide could include, but is not limited to:

- Opening hours, e.g. those listed publically where relevant, or sign-off from appropriate person within the organisation
- Output from a Building Management System showing time of use settings
- Operational schedules e.g. for manufacturing
- Interval meter data if available
- Sensible rationale and sign-off for equipment in use 24/7, e.g. emergency lighting

M&V Plan Completion Steps

Under the "Project detail and peak relevant savings" tab:

You should first provide a summary of the time of use of equipment over the winter peak period in the yellow free text box on the 'Project detail and peak savings tab'. You will then need to describe the peak relevance of technologies included in your project.

You will need a new line for each site, technology and time of use grouping.

For example:

Site A

Has 20 pumps that are all operating for the entire peak period

Complete 1 line for all 20 pumps

Site B

Has 20 pumps 10 of which are operating for the entire peak period and 10 of which are operating for the first 2 hours only.

Complete 1 line for the first 10 pumps and one line for the second 10 pumps

Site C

Has 10 pumps that operate for the whole peak period and 10 motors that operate for the whole peak period

Complete 1 line for the 10 pumps and 1 line for the 10 motors

Under the "Project detail and peak savings" tab of the template M&V Plan, you should include the following:

- Site code – use the site codes you have specified on the Project Payback tab.
- Existing technology – in the format number, make, description e.g. 20 45kW motors
- Expected demand reduction: please complete **EITHER** columns H or I:
- Column H: If you know the kW demand reduction taking into account how many peak hours it will apply to, complete this column. You still need to complete columns K-O and R (i.e. provide a breakdown of peak relevance) for audit purposes.

- Column I: If you know the kW demand reduction but haven't taken into account how many peak hours it will apply to, complete this column. The values will be adjusted for peak applicability as specified in columns K-O.
- Peak Applicable Hours - as described above, please select 'yes' for those hours when your technology is operational. Select 'yes' only if the technology is applicable for the full hour.
- No. of days applicable across the peak period (1 November to 28/9 February inclusive) – this is the number of days that your stated peak applicable hours are relevant to across the peak (weekdays, Nov – Feb inclusive, excluding bank holidays) and will default to 83 days (100%). You may not enter a number higher than 83 (even if you operate on bank holidays or weekends). You may however, enter a number lower than 83. Examples are:
  - We close for 2 weeks in December (reduce by 10 days) = 73
  - We don't work Fridays (reduce by 17 days) = 66
- Please describe the operational period of your equipment including the number of days. If your number of days in anything other than 83 you need to provide a description of why. Examples are as above:
  - 73 - we close for 2 weeks in December
  - 66 - we don't work Fridays

On the Cover Sheet tab:

- Evidence of kW EDR bid – you will need to state the file names of the attachments to your M&V Plan that substantiate your kW bid (see evidence requirements above).

End of Section Checklist

By the end of this section, you should have:

- ☑ Completed the "Project savings and peak savings" tab including the technologies and associated time of use for all equipment included in your project
- Made sure that you are only bidding the peak applicable kW saving into the auction (not total kWh savings)
- Made sure you have supplied suitable evidence to support your kW bid and labelled it using follow the naming convention: Application ID, kW saving, description of file, ddmmyy.

e.g. **GHTT0708-876 kW saving supplier audit 030515**

e.g. **GHTT0708-876 kW saving calculations 030515**

- Where possible it would be preferable if you could consolidate your evidence submissions e.g. putting all the kW saving evidence into one file with a coversheet that references the evidence would be preferable to avoid too many attachments.

Section summary: project detail and peak savings

REQUIREMENT

Projects must deliver an average of at least 100kW of savings over the winter peak period to be eligible to participate in the pilot. Equipment being bid into the pilot is recognised in the proportion to which it is operational during the peak period. You are required to provide a breakdown of all the technologies in your project and their time of use. This will be used to calculate the average kW savings of your project over the peak period.

DESCRIPTION

The winter peak period is 4-8pm, weekdays from the beginning of November to the end of February (a total of 83 days). You will need to provide a breakdown of the peak relevance of each technology included in your project. This includes the number of days that the equipment is operational for and the typical hours of operation between 4-8pm.

WHAT YOU HAVE TO DO

Fill out the 'project detail – peak savings' tab of the M&V template. This will involve providing a breakdown of the kW savings of the different technologies included in your project and their time of use.
Where time of use varies for the same technology you will need provide a separate entry for each time of use grouping.
For each technology and time of use grouping you will need to provide:

- the kW saving of the technology
- the number of days and hours (between 4-8pm) that it is operational
- a summary description of the peak relevance of the technology

EVIDENCE REQUIREMENTS

Participants are required to append evidence to substantiate the kW saving estimates of their projects to their M&V plans e.g. supplier audits, calculations etc.
Participants may also be asked to provide evidence to substantiate the peak-relevance of technologies included in their projects.

EXAMPLE

If you have 1 site with two technology types e.g. motors and HVAC control each of which have different times of use you will provide a total of 2 lines of information.
If you have 2 sites with 3 technologies at one site all with different times of use and 1 site with a single technology type with the same time of use you will provide a total of seven lines of information.

2.4. Operational Verification

Section Overview

This section provides guidance on how to fill out the following tab in the M&V template:

- Operational Verification

Operational Verification refers to activities that take place once the new equipment is installed, aiming to make sure that they are working as intended with the potential to generate the expected electricity reductions. It is important to make sure that the operational verification procedures that will be followed for each technology are established prior to their implementation.

You should expect your supplier to be able to provide details of the process that should be followed once their technology is installed in order to ensure that it is working properly. Operational Verification processes may be carried out by the supplier, an external consultant or the participant themselves.

Regardless of the approach taken to measure the savings from the EDR project, the procedures for operational verification are required for each technology type included in your bid. Where supplier guidance indicates that different operational verification activities should be carried out within the same technology type details of operational verification activities for each separate process should be provided. For example, if a firm is installing 5 motors at one site all of which involve the same OV procedures then providing detail on the single procedure would be acceptable. If however the OV activities varied between the motors e.g. one motor follows a different process then separate OV information would have to be supplied for the four motors using one approach and the fifth motor using another approach. You should also describe the equipment in your project that is captured by your OV process so it is clear to any third party which parts of your project will follow which OV procedure.

You will need to provide your operational verification evidence no later than the final installation deadline for your equipment, by 15 October 2015.

In the “Operational Verification” tab of the M&V Plan Template, you should include details of the Operational Verification activities you will follow when the equipment is installed in column E. This would typically be expected to be the commissioning procedure but where this is not available or possible you should describe the procedure you will follow in column E. You can append a document describing the procedure if preferable.

Once you have installed the equipment you can then attach the required evidence set out in column F ‘Post installation evidence’. See section 3.1 ‘Reporting operational verification’ for more detail.

TO NOTE FOR DEEMED APPROACHES YOU SHOULD PROVIDE DETAILS OF OPERATIONAL VERIFICATION IN THE DEEMED SPREADSHEETS, NOT THE MAIN M&V TEMPLATE.

Operational verification activities will depend on the nature of the equipment installed, but could include:

- A visual inspection
- Measurements from a sample of installations – please provide a rationale for sample size used.
- Established commissioning procedure followed by the supplier every time their technology is installed.

An example of an OV procedure is provided in Appendix C.

Once you have installed the equipment you will have to provide evidence of operational verification. Further detail on the evidence required is provided in the section on operational verification as part of post-implementation activities (section 3.1).

Documentation for Operational Verification can be appended to the M&V Plan as required.

Please ensure that for all evidence files you follow the naming convention:

Application ID, record category, description of file, ddmmyy

e.g. **GHTT0708-876 OV LED supplier commissioning procedure 030515**

M&V Plan Completion Steps

Under the "Operational Verification" tab of the M&V Plan Template, you should include details of the Operational Verification activities.

The Site Code, and replacement technology description will copy over from the "Project detail and peak saving" tab. You will then be required to provide, for each technology:

- The operational verification procedure you will follow. You can reference the relevant file in column E.
- After you have installed the equipment you will need attach the evidence you will provide e.g. a commissioning certificate for equipment installed and describe the evidence provided in column F (see section 3.1 'Reporting operational verification' for more detail).
- Where possible it would be preferable if you could consolidate your evidence submissions e.g. putting all the OV evidence into one file with a coversheet that references the evidence would be preferable to avoid too many attachments.

End of Section Checklist

By the end of this section you should have:

- Completed the Operational Verification tab of the M&V Plan

Section summary: operational verification

REQUIREMENT

You are required to set out the activities you will undertake to ensure the equipment included in your project is properly installed and configured. This is to help ensure that efficiency measures work as intended and have the capacity to deliver expected savings.

DESCRIPTION

Your supplier should be able to provide guidance as to the appropriate operational verification activities that should be carried out. You will need to provide information of the operational verification activities you will carry out for each technology type included in your project and, where the procedure varies within each technology type, for each variation.

OPERATIONAL VERIFICATION ACTIVITIES

Activities will depend on the equipment installed, but could, for example, include:

- visual inspection
- measurements from a sample of installations
- following an established commissioning procedure

Consult your supplier for further information

WHAT YOU HAVE TO DO

Fill out the 'operational verification' tab of the M&V template. Each technology type and time of use grouping will be auotmatically copied over from the 'Project detail and peak saving' tab. You will need to provide OV process descriptions for each. Where OV processes vary you will need to describe the OV approach for each approach.

EVIDENCE REQUIREMENTS

Prior to installation and in the M&V template provide, for each technology type in your project and, where OV processes vary within the same technology type, describe the operational verification activities you will undertake for each type.

Once the equipment is installed you will have to provide:

- proof of purchase of the equipment (e.g. receipts to cover all the equipment purchased);
- a commissioning certificate to cover each technology type included in your bid– see the manual for more detail.

EXAMPLE

Each technology type and time of use grouping will automatically copy over from the 'Project detail and peak saving' tab. If, for example, you have 1 site with a single technology and three time of use groupings you will have a total of 3 lines to complete. If the OV process for the technology is the same you can simply copy the process detail and evidence for each line.

2.5. M&V Approach and Boundary

Section Overview

This section provides guidance relevant to filling out the following tabs in the M&V template:

- 'M&V approach and boundary'

This section tells you how to select the most appropriate M&V approach(es) for your project and how to identify your Measurement Boundary or Boundaries where more than one is required.

Using this, you should use your M&V Plan to:

- State your measurement approach(es) under "M&V Approach & Boundary" tab.
- State the Measurement Boundary(ies) included in your project under the "M&V Approach & Boundary" tab.

THE M&V PLAN COMPLETION STEPS INTHIS SECTION OF THE MANUAL ARE NOT APPLICABLE FOR THE DEEMED SAVINGS METHODOLOGY.

2.5.1. Introduction

The purpose of this section and the following chapter is to help you:

- **select the right M&V approach(es) for your project**

If you need to use an approach involving the collection of metered data it will also help you to:

- **define the appropriate measurement boundaries for collecting data.** A measurement boundary includes all the equipment that is captured by a particular meter.
- **provide the required baseline data and information** (covered in more detail in the next chapter)

Projects will have to deliver an average of at least 100kW of savings over the winter peak period to be eligible for the pilot. To meet this requirement some projects may have to aggregate savings across multiple sites and may include a range of different technology types (e.g. pumps, motors, lighting controls etc.). It may therefore be necessary to adopt more than one measurement and verification approach to measure the savings from your project.

The next section provides an overview of the M&V approaches available to measure and verify the savings of your project. It also provides further information on how to define the measurement boundaries under each approach.

2.5.2. Choosing M&V approach(es) for your project

In total there are four M&V methods that you can use to measure and verify savings in the pilot. Providing you meet the requirements of an approach, you are free to choose which approach, or approaches, you use.

The four methods are:

- **Deemed savings** – for simple projects involving a swap of one product for a more efficient version that are on the deemed list participants can use 'deemed savings'. Under this approach spreadsheets are used to calculate savings with details of both the existing and replacement technologies supplied by the participant. Appendix B provides more details on deemed technologies. Only technologies on the list can be deemed, as follows:
  - Lighting
  - Lighting controls
  - Motors & Variable Speed Drives (VSDs)
  - Process Chillers
  - Heating controls
  - Retail Display Cabinets (RDCs)
  - Professional Refrigerated Storage Cabinets (PRSC)
- **Three metered approaches** – for more complex projects involving multiple electricity-saving measures, industrial processes, or technologies not covered by the deemed savings list or where actual measurements of savings are required you can select one of three methods involving the use of electricity meters. These are all based on the International Performance Measurement & Verification Protocol (IPMVP). These are:
  - Partial measurement
  - Full measurement: Submetering
  - Full measurement: Total Building Electricity

For some projects, it is possible that more than one approach is suitable, or that different approaches could be taken to measure different measures within the project. Where different approaches are taken, you must ensure that savings are not double counted. Your supplier will be able to provide some input where they have experience in measuring the performance of their technology.

An overview of the four approaches is provided on the next page. This is followed by one page summaries of each M&V approach and a decision tree to help you decide which approach(es) are suitable for the site(s) included in your project.

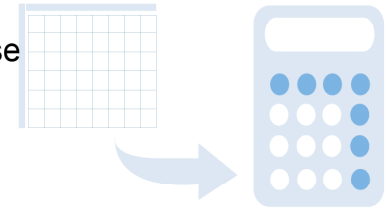
You should use the decision tree to decide on the appropriate M&V approach for each site included in your project.

Load

The term "load" in this context refers to the power requirement of equipment that is converting electricity into something useful, for example heating, lighting or mechanical motion. For these examples, heaters, light bulbs or motors would draw a given load (in kW) in order to carry out their function. Loads are often classified according to type, so for example, an IT load would refer to the power drawn by the IT equipment.

OVERVIEW OF M&V APPROACHES IN THE PILOT

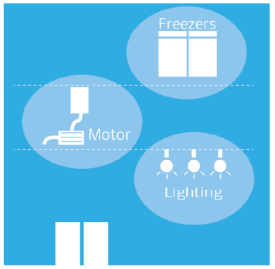
Deemed savings savings



Savings are calculated through the use of spreadsheets. No meter data is collected. Only technologies on the deemed list can be deemed, this includes:

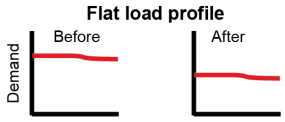
- Lighting
- Lighting controls
- Motors & Variable Speed Drives (VSDs)
- Process Chillers
- Heating controls
- Retail Display Cabinets (RDCs)
- Professional Refrigerated Storage Cabinets (PRSC)

Partial measurement

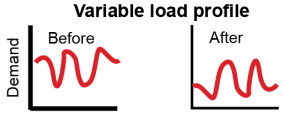


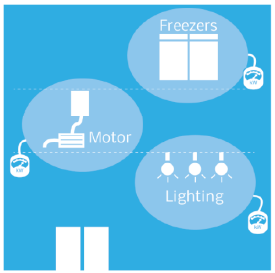
Savings are measured by taking meter readings before and after implementation. Because levels of demand are flat (and therefore consistent over time) a set period of readings can be taken and then time of use applied to calculate savings.

Measurement boundary: drawn around the load type affected by the efficient equipment e.g. lighting, freezers and motors would all have separate boundaries as shown above.



Full measurement: submetering

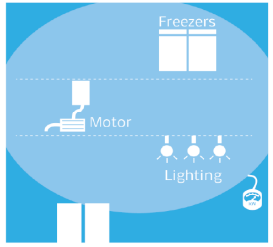




Demand is variable so it is necessary to monitor the equipment throughout a full operating cycle to calculate savings. Sub-meters are used to record consumption for different equipment types.

Measurement boundary: drawn around the sub-meters used to collect metered data e.g. the three separate sub-meters shown above.

Full measurement: whole site

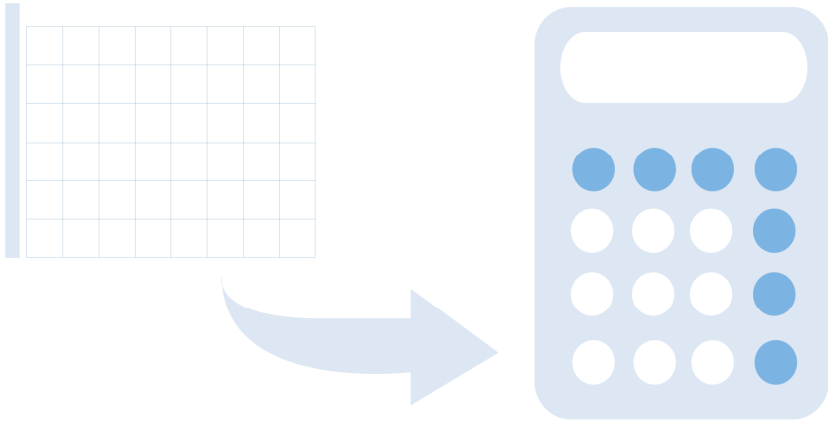


Savings >10% of total site electrcity use

A site meter is used to calculate savings at a site level. Data is collected over the baseline and reporting period. Expected electricity savings must be greater than 10% of total electricity use at the site to make this approach suitable.

Measurement boundary: drawn around the building as shown. The site meter captures the consumption from all electrical equipment included in the building as shown above.

Deemed savings



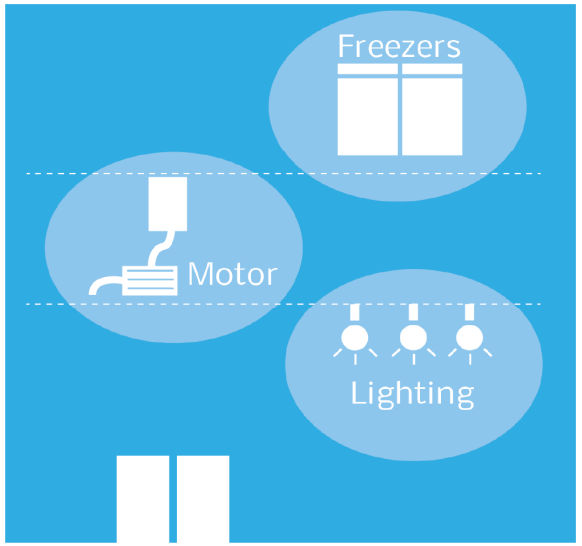
Summary: Under the deemed savings approach the details of the existing and replacement technologies are entered into a spreadsheet to calculate savings. There is no need to collect metered data.

Description: savings are calculated based on a mixture of input data (e.g. type of equipment being replaced, details of the replacement, and the time/application of use) and deemed or assumed factors, which are defined based on research, historical experience and expert guidance. This approach can only used for technologies on the deemed list, which are:

- Lighting
- Lighting controls
- Motors & Variable Speed Drives (VSDs)
- Process Chillers
- Heating controls
- Retail Display Cabinets (RDCs)
- Professional Refrigerated Storage Cabinets (PRSC)

Further details on deemed savings and the calculators can be found at Annex B.
It is not compulsory to use deemed savings for technologies on the list. For example, you may require actual meter readings to calculate savings for your project in which case you should one of the three metered approaches.

Partial measurement

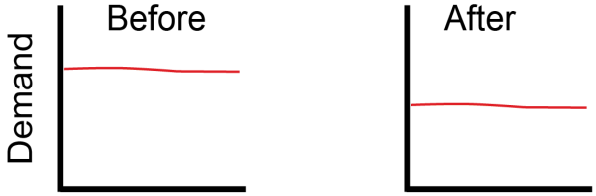


Summary: savings are measured by taking metered readings of equipment installed. Because levels of demand are flat and therefore consistent before and after implementation a set period of readings can be taken and then time of use applied to calculate savings.

Description: savings are determined by directly measuring the kW demand of equipment before and after the installation of the equipment. The peak applicable hours of operation should be estimated in order to provide the overall average demand reduction during peak hours. You may be asked to provide evidence or information as to how the peak period of operation has been esitmated.

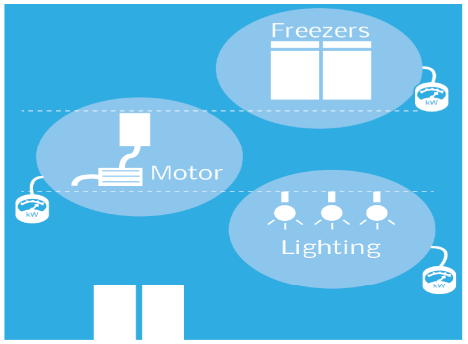
Conditions for use:
This approach can only be used where demand has a flat load profile before and after implementation and there is no seasonality in demand (time of use can be applied to calculate savings over the peak period) and it is possible to take direct measurements of the equipment being installed.

Flat load profile



Measurement boundary: for this M&V approach, the measurement boundary should be drawn around the load type vaffected by the equipment, for example the lighting circuits or a number of fittings included in a lighting retrofit as shown in the diagram above. Sub-meters or temporary meters can be used to measure the savings for each load type of interest. Evidence should be provided for meter calibration. Baseline data will need to be collected and provided for each separate measurement boundary e.g. if you have two different boundaries baseline and reporting data will need to be collected for each.

Full measurement: submetering

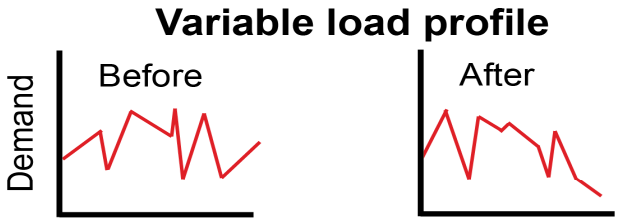


Summary: demand is variable so it is necessary to monitor the equipment throughout operation to calculate savings. Sub-meters are used to record consumption for different equipment types.

Description: Peak demand reduction is determined using submetering, allowing a comparison of energy consumption of equipment before and after the installation of the equipment. Examples include controls, variable speed drives, space heating or cooling equipment, where measurements taken via a partial measurement approach would not be representative of all conditions. The metering could capture more than one efficiency measure of the same type, for example a project to retrofit both lighting fittings and lighting controls.

Conditions for use:
This approach is suited to projects where:

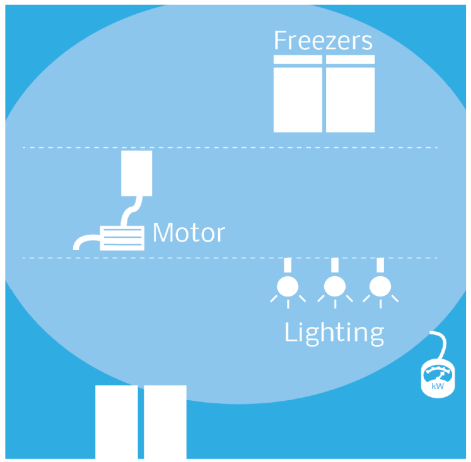
- demand has a variable load profile before and after implementation
- it is possible to take direct measurements of the equipment being installed through sub-meters



Measurement boundary: for this M&V approach, the measurement boundary should be drawn around the submeter(s) used to capture the effect of the equipment being installed, including details of the load they are metering and the time interval.

Baseline and reporting information will need to be provided for each separate measruement boundary. For example in the example above lighting, motors and freezers have their own submeters. Baseline and reporting data would need to collected for each boundary (a total of 3) to measure and verify savings at the site.

Full measurement: whole site



Summary: a site meter is used to calculate savings at a site level. Data is collected over the baseline and reporting period.

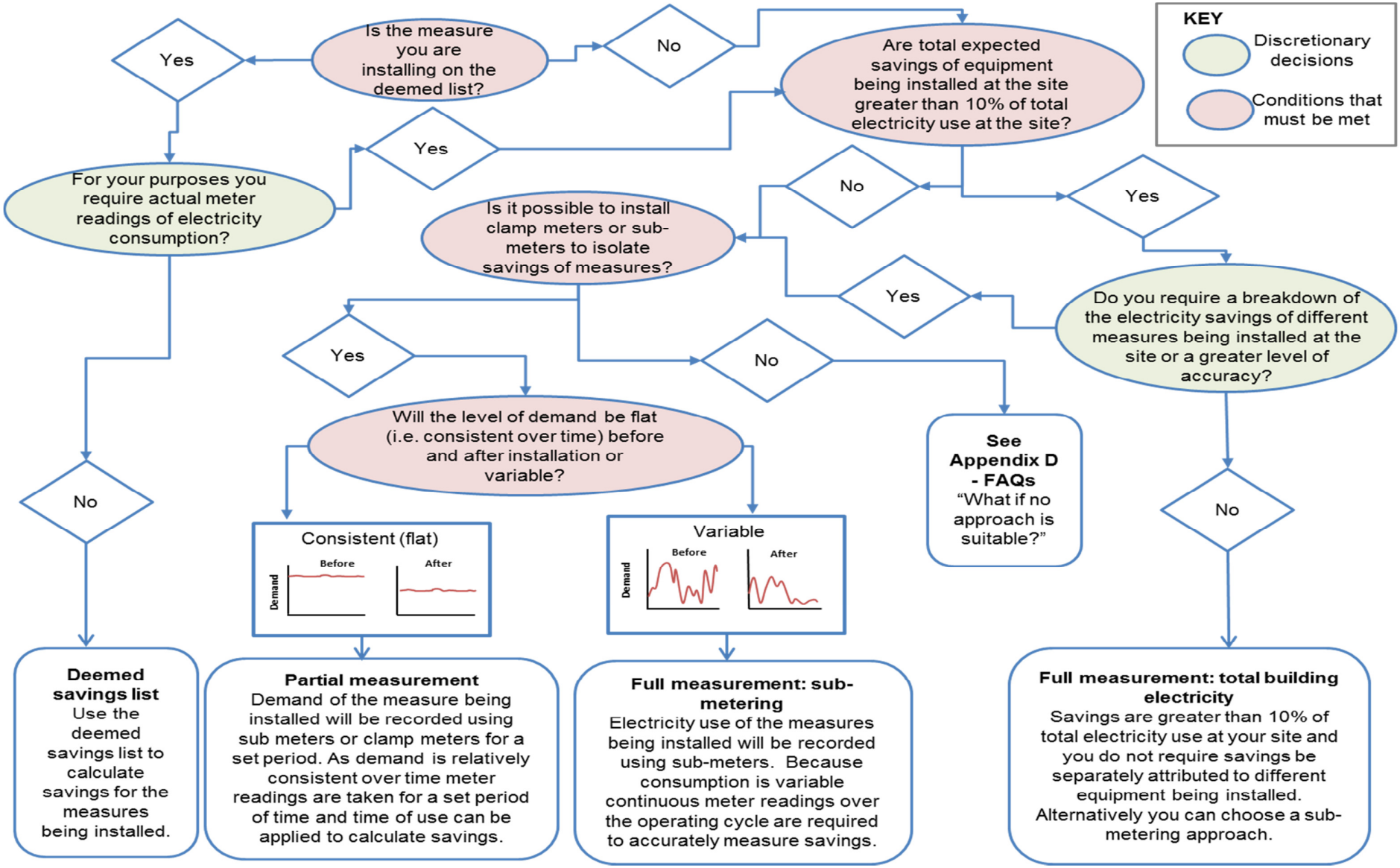
Description: peak demand reduction is determined using electricity data for the total building before and after the installation of efficiency measures. As with other approaches electrical kWh data will need to be converted to an average kW demand value for peak relevant hours to enable the average reduction in kW demand over the peak hours to be reported.

Conditions for use:
This approach is suited to projects where expected efficiency savings are greater than 10% of total electricity use at the site and a breakdown of savings by technology type is not required.

savings >10% of total site electrcity use

Measurement boundary: for this approach, the measurement boundary will be drawn around the total site electricity consumption. Electricity from the grid will be captured by your utility meter and available from the electricity supplier, usually at half hourly intervals. If existing on-site generation is used, you should identify this and document how data from this is captured.

M&V approach decision aid tool

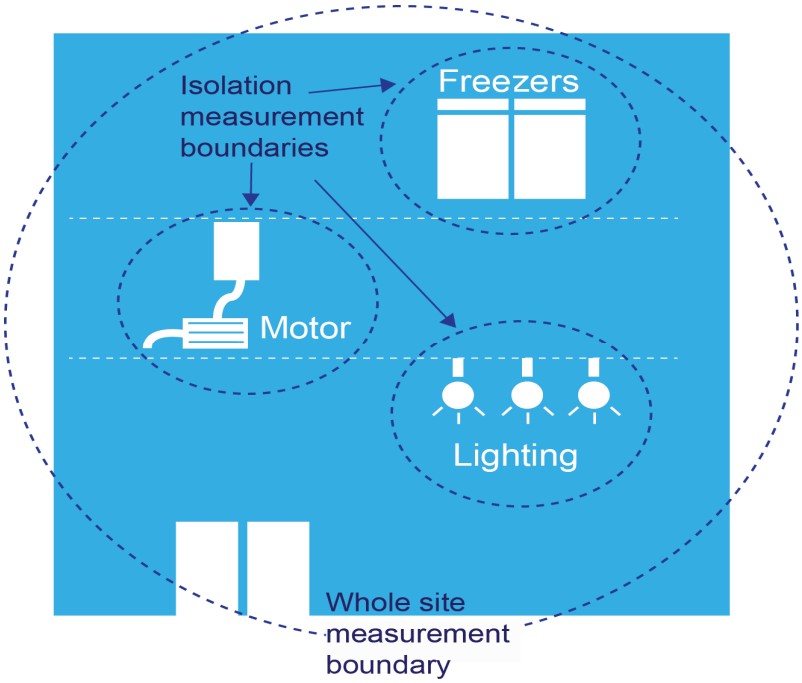


2.5.3. Measurement boundary

This refers to a notional boundary drawn around the equipment that will be measured to calculate demand reduction, i.e. what is captured by your metering – either just the technologies affected by the EDR project, or a wider boundary such as the whole building. This is so you can make clear exactly what will be captured by the meter readings taken.

The measurement boundary or boundaries you choose will be driven largely by the M&V approach you choose for measuring your project as indicated in the previous diagrams and shown below. Your choice of M&V approach may itself be influenced by factors such as the availability of metering, the need to break down savings by technology type etc.

- For partial measurement and full measurement: submetering approaches, these will involve isolating the technologies in the EDR project, so the measurement boundary will be drawn around them. Submeters or clamp meters will be necessary.
- For a full measurement: total building approach, the measurement boundary will be drawn around the total electricity supply. A site meter would be used.



Examples of Measurement Boundaries

Consider an example where each of the technology types in the diagram above formed part of an EDR project. It may be possible to isolate each technology, developing a separate measurement process for each and the results aggregated. Alternatively, the total effect could be measured from the total electricity supply for the site.

Measurement Boundary Selection	No. of Boundaries Required
Isolate technologies, drawing a different measurement boundary around the freezers, motors and lighting technologies individually.	Three (one for each technology type)
Measurement of the total effect of all demand reduction measures by drawing a measurement boundary around the whole site.	One (this would usually use the site utility meter data)

The number of measurement boundaries required for your project will depend both on the number of sites in your project and the M&V approach(es) you choose to measure and verify savings. It may also be influenced by the role of interactive effects.

Interactive effects

Interactive effects refer to electricity effects that happen outside of the measurement boundary. For example, in a lighting retrofit project, the measurement boundary would include the electricity supply or demand of the lights. However, by switching to more efficient lighting, the heat output of the lighting may also reduce, the effect of which would be outside of the measurement boundary.

The measurement boundary should be drawn to minimise interactive effects, i.e. if there are several measures that have interactions in the way that they reduce demand, then the measurement boundary should be drawn around the total electricity supply rather than individual measures.

2.5.4. Sampling

Where projects are:

- sufficiently large and are made up of a single technology
- formed of a number of sites and the technology(ies) being installed at each site are the same

a sampling approach may be used to measure and verify savings. For sampling to be appropriate the technologies being implemented should be the same and conditions sufficiently similar within the site (or across sites) to make it a viable approach. Sampling aims to reduce the measurement burden whilst providing sufficient evidence from measurements to confirm that the technologies in the project have achieved the expected demand reduction. Guidance on establishing sample sizes is included in Appendix G – Sampling Approaches. Sample sizes should be calculated in accordance with this.

Illustrative examples

Project A has three sites. Sites one and two involve the replacement of process chillers and lighting which the participant chooses to deem. However, sites two and three also involve the replacement of electrical motors and pumps involved in manufacturing which requires a full measurement sub-metering approach to measure savings. This metering involves two separate measurement boundaries at each site resulting in baseline and reporting data being provided for a total of four different measurement boundaries.

Project B has nine sites. Retail display cabinets are being replaced at all nine sites for which the participant chooses to use deemed savings. At site seven they are also upgrading their HVAC system and pumps and savings are expected to be greater than 10% of total electricity use at the site so they choose to use a whole site metered approach for this site. They use the deemed calculators and collect and provide site meter data for site seven to measure and verify the savings of their project.

M&V plan completion steps

- Decide what M&V approach(es) will be used to measure savings from your project.
- If using a metered approach, define the associated measurement boundaries associated with each approach.
- Go to the 'M&V Approach and Boundary' tab within the M&V Plan Template.
- For each Measurement Boundary complete the following section:
  - **Boundary Code:** assign a number in column B sequentially for each boundary (i.e. B1, B2, B3 etc.).
  - **Site Code:** in column C, identify which site each boundary is linked to by using the site code originally given in the "Project Payback" tab.
  - **MPAN:** in column D, provide the Meter Point Administration Number (MPAN) of the site meter.
  - **Project Component:** In column E, describe the technologies that are covered within the Measurement Boundary – this will be either individual technologies if you are using Partial Measurement or Full Measurement: Submetering, or all of the technologies at the site if you are using Full Measurement: Whole Site.
  - **M&V Approach:** Select the M&V Approach you are using for each boundary from the dropdown list in column F.
  - **Measurement Boundary Description:** provide a description of the Measurement Boundary in column G. This should include details of the equipment included in the boundary, how readings will be taken, for example, from temporary metering, submetering or a utility meter and whether or not sampling will be used.

2.6. Baseline - overview

Section Overview

If you are using an M&V approach involving the use of metering, from the previous section you should have identified the associated measurement boundaries. The purpose of this section is to:

- explain how you should define the baseline for each measurement boundary – including the length of the baseline period and if any adjustments are required to accurately record savings; and
- give an overview of the information you need to provide on your baseline for each of the different M&V approaches.

Using the guidance in this section, you should use the "Baseline" tab in one of the three Template Calculation Sheets to provide your baseline for each set of readings. You will need to save a separate spreadsheet for each measurement boundary.

- "Template Calculation for Partial Measurement.xls"
- "Template for Full Measurement - Average Readings.xls"
- "Template for Full Measurement - Regression Analysis.xls"

THIS SECTION OF THE MANUAL IS NOT APPLICABLE FOR THE DEEMED SAVINGS METHODOLOGY (see Appendix B for more detail on deemed savings).

2.6.1. Calculating the baseline of your project

If you are using any of the three metered approaches to measure savings from sites included in your project you will need to provide baseline and reporting data for each measurement boundary included in your project (see the previous section for more information on measurement boundaries). For example, if you have six separate measurement boundaries across three different sites you would have to provide baseline and reporting data for six boundaries to measure and verify the savings from your project.

This chapter provides an overview of the information you have to provide on your baseline. It is divided into two parts:

- the first part provides general guidance for defining your baseline including:
  - how you should decide the length of your baseline period (i.e. how long you need to take readings for); and
  - whether adjustments to the baseline are needed to accurately calculate savings
- the second section moves onto provide more detailed baseline guidance that is specific to each of the three different metered approaches. You will need to consult the section(s) that relate to the M&V approach(es) you have chosen to measure the savings of your project.

2.6.1.1. Baseline & Adjustments

The baseline refers to the period of readings taken before the new equipment has been installed. It provides a counterfactual against which savings are measured. The basic principle is to measure electricity demand over the baseline period and compare it with demand over the reporting period to calculate the savings achieved. Baseline and reporting data will be required for each measurement boundary included in your project.

In practice, the actual baseline data that is provided will depend on the approach taken to measure savings. For many projects the baseline data that will be provided will cover the winter 2013/14 period and potentially be as long as a year where there is seasonality in demand. The corresponding reporting period would be winter 2015/16. For other approaches, where shorter baseline and reporting periods are suitable, it may be that data can be collected during other periods.

The information you need to provide includes:

- the baseline demand or electricity data;
- the dates used to calculate it;
- any adjustments to the data to account for variations in electricity use; and
- associated accuracy calculations

There are two steps to establishing a baseline for your project:

i. Determine how long the baseline period should be

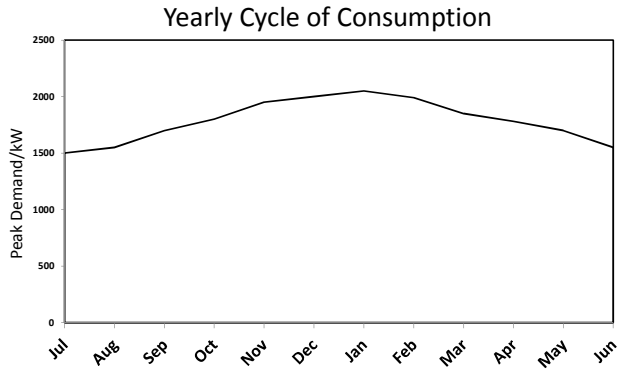
ii. Determine if any adjustments are needed to take account of factors that affect demand

Step 1: Determine how long the baseline period should be

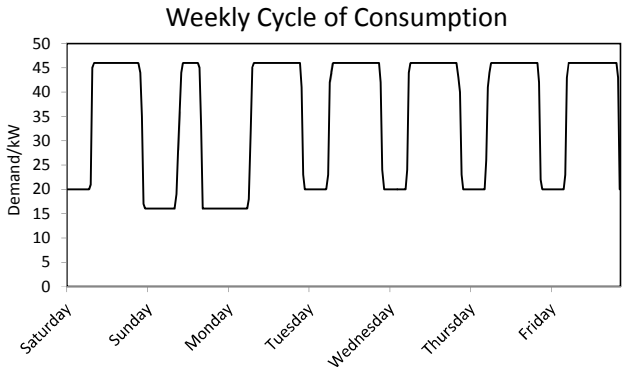
It is important that the baseline is representative of normal operation during peak hours. If there are variations in demand, this should include a full cycle of operation (see below). Your baseline period should cover the most recent full range of operating conditions of the equipment within the measurement boundary.

Cycles of Consumption

A cycle in this context refers to the amount of time between successive similar operating modes, either of a whole building or individual technology. The energy use of a building or technology may change in response to variables, for example, external temperature or operating procedures.



The length of a full cycle of operation will be determined by the amount of time needed to elapse for a full range of operating modes to be experienced. At the total site level, buildings such as offices, hospitals or retail sites, a full cycle is taken as a calendar year if there are seasonal variations. Baselines with any seasonal variation should therefore include the winter peak 2013/14 as part of the calendar year.



For individual technologies, it may be shorter, for example, motors used in an industrial process or lighting in a retail site with a weekly cycle. Where there is no seasonal variation, i.e. operating cycles are the same throughout the year, then the cycle of operation does not have to coincide with winter peak as use of the equipment would confidently not be expected to be any different over this period. However, the operating cycle must be representative of the full range of normal equipment operation.

Examples of Cycle Lengths

Project	Cycle	Rationale
HVAC replacement in a hotel	1 calendar year	The HVAC system electricity demand is dependent on external temperatures, therefore a calendar year captures a full cycle of conditions
Variable speed drive in a production plant	1 month	The equipment affected by the variable speed drives is dependent on production volumes. A full range of expected production volumes would be experienced at the plant over the course of a month.
Lighting upgrade in an office	1 week	Lighting patterns are not impacted by the external environment and follow the same weekly pattern throughout the year and are not expected to change during the baseline and reporting periods.

Once you have determined the length of the baseline period you will need to set out the length of the baseline period for each measurement boundary in your project, and explain why the baseline period chosen is sufficient to capture a full operating cycle of the equipment being measured. See the M&V completion steps at the end of this chapter for more information.

The table below shows the suggested baseline and reporting periods for different operating cycles. While the length of the baseline period is typically driven by the length of the operating cycle of the equipment being measured, you will also need to check that the readings to be used for the baseline meet minimum accuracy requirements (see Appendix F). In some cases the baseline period may need to be longer than the operating cycle to meet accuracy requirements (i.e. you need more readings to meet the accuracy requirements).

Operating cycle	Baseline data requirement	Reporting data requirement	Comments
1 week	At least 1 week, although you may need to provide readings for a longer period to meet the accuracy requirements (see Appendix F)	Your reporting data length should match your baseline data length if possible but should cover a minimum of 1 week.	A full 12 months of baseline data would be of value for evaluation purposes. If it is feasible to provide this we would be very grateful to receive it.
1 month	At least 1 month, although you may need to provide readings for a longer period to meet the accuracy requirements (see Appendix F)	Your reporting data length should match your baseline data length if possible but should cover a minimum of 1 month.	A full 12 months of baseline data would be of value for evaluation purposes. If it is feasible to provide this we would be very grateful to receive it.
>4 months	Your baseline should cover a full operating cycle. However, if you do not have a long enough data period you must provide a minimum of the 4 month winter peak Nov 13 – Feb 14. You must ensure your provide sufficient readings to meet the accuracy requirements (see Appendix F).	A minimum of the 4 month winter peak Nov 15 – Feb 16	For evaluation purposes we are seeking a full 12 months of baseline data for those with operating cycles of 4 months or more. If it is not possible for you to provide this please discuss with DECC edr-project@decc.gsi.gov.uk

An example of situation where baseline data would be required for a full year would be measuring savings from voltage optimisation. This is because voltage supplies will tend to vary throughout the year and so measuring equipment at only times of high voltage would give an over optimistic assessment of performance.

Step 2: Determine if any adjustments are needed to take account of factors that affect demand

When calculating your baseline, you may need to apply adjustments in order to provide a fair comparison once a measure has been installed. You will need to determine whether adjustments are required when calculating your baseline.

For the purposes of M&V, adjustments refer to the need to take into account other factors in the calculation of a change in demand, rather than a raw comparison of a data set before and after installation.

Examples of Adjustments

Consider a factory installing a more efficient pump which plays a key part of its production process manufacturing plastic containers. Electricity use is measured over the baseline period. In the reporting period, the firm receives a large order for containers from a new client and has to increase production to meet demand.

Without any adjustment to the baseline data, electricity use during the reporting period would now be higher than the baseline period despite there being a more efficient motor in place. To take account of this increase in production volumes an adjustment can be applied to the baseline data to show what electricity use would have been had the original motor continued in operation. This enables a savings figure calculated that takes account of key variables affecting performance.

Examples of key factors that affect electricity consumption for different kinds of technologies are listed below; this is for illustrative purposes and is not exhaustive. It is provided to help you think about the factors that may have an impact on electricity consumption on your site and adjustments you may need to make to the baseline. It is your responsibility to identify if adjustments to the baseline are required to accurately measure savings and to collect the required data to make any adjustments that are required, whether they are routine or non-routine (see below).

- HVAC: temperature, building occupancy
- Pumps/Motors: production volumes, time of use
- Chillers: temperature
- Lighting: time of use, building occupancy

Adjustments are generally considered to be either “routine” or “non-routine”.

Routine adjustments refer to factors that would be expected to change frequently over time, for example external temperature, daylight levels, or production volumes. These factors are known as “independent variables” and their effect can be determined using a regression analysis, which is further described in Appendix F “Checking the Accuracy of Your Baseline”. You must identify routine adjustments upfront and identify them as part of your plan.

Independent variables

An independent variable is a factor that would be expected to change frequently, but also have a measurable impact on electricity use of a building or individual technologies within that building.

The most common example at the whole building level is external temperature. Other examples include production volumes, building occupancy and time of year as shown in the previous examples box.

Routine adjustment examples

Building Type/Process	Independent Variables
Retail building with refrigeration equipment	External temperature
Hotel	Occupancy levels of the rooms, time of year
Hospital	Occupancy levels, external temperature
Manufacturing Process	Production volumes for the process

Non-routine adjustments refer to changes that would not be expected to change frequently, for example, installation or decommission of large plant and equipment (unrelated to the equipment that has been installed).

Non-routine adjustment examples

Cause of adjustment	Adjustment process
Additional IT load (e.g. increase in no. of desktop computers)	The increase in load could be established using an existing submeter where one exists. Alternatively, a sample of the computers' demand could be monitored and extrapolated for the population of computers. The IT load before and after the increase can be compared to calculate the amount that should be added to the baseline. Without this addition, savings would be under-reported.
Change in use of lighting load (e.g. permanent reduction in use of outdoor lighting from 4 – 5pm)	The adjustment could be measured from an existing lighting submeter or via a sample of lights to establish the load and estimate time of use. The adjustment should be subtracted from the baseline in order to avoid over-estimating the level of savings.

Once you have decided if adjustments are required to the baseline you will need to describe the approach to adjustments for each measurement boundary included in your project. For

example, where no adjustments are required, a short description of why the measures included in the measurement boundary are not going to be affected by other variables affecting demand is required. If adjustments are going to be required a short description of what factors will be used to adjust demand and why must be provided. A description of the data that will be collected to monitor the independent variable must also be included. See the M&V completion steps at the end of this section for more detail.

M&V plan completion steps

- In the 'M&V Approach and Boundary' tab within the M&V Plan Template. You should provide the following:
  - **Measurement boundary length**: you will have to provide detail on the length of the baseline for each measurement boundary (column H) and a summary of why the length chosen is sufficient to accurately measure savings of equipment included in the boundary in column I. You also need to have checked that your baseline meets minimum accuracy requirements (see Appendix F for more detail).
  - **The approach to adjustments**: in column J state whether you will be making any adjustments to the baseline and in column K you will need to justify the approach chosen e.g. why no adjustment is required or where it is required why and describe the variable(s) that will be used to adjust the baseline and data that will be collected for the independent variable. If you need to take account of more than one factor then you can use multiple regression. You can contact DECC if you are unsure how to do the multiple regression analysis edr-project@decc.gsi.gov.uk

End of Section Checklist

By the end of this section, you should have decided, for each measurement boundary included in your project:

- how long the baseline period needs to be; and
- if adjustments to the baseline are required to take account of other factors that will affect demand e.g. temperature, production volumes etc.
- Note that where adjustments are required for other factors, you will need to identify data sources and continue to collect data used to calculate the adjustments. This data will be required for your baseline calculations and savings reporting.

2.7. Baseline – detailed guidance on collecting data and calculating savings

This next section provides more detailed guidance on providing a baseline for each M&V approach.

Whichever M&V approach you are using you will need to:

- Collect raw metered data over the baseline and reporting periods – this would typically be expected to be in half hourly format though those using manual clamp metering approaches may provide readings at a different frequency.
- For full metered approaches you will have to calculate the average kWh or kW value over the peak period from the raw data and then input the average values into the spreadsheet to calculate the kW demand value.
- In the case of partial measurement approaches you will need to input the relevant readings and time of use to calculate savings.

You are required to include details of baseline calculations as part of your application and submit all the raw data (including for non-peak periods). This is so that the peak kW data can be checked and verified.

You will need to input your data in one of the three calculation spreadsheets:

If using a **partial measurement** approach use:

- 'Template Calculation for Partial Measurement'

If using either of the **full measurement** approaches use:

- Template Calculation for Full Measurement - Average Readings
- Template Calculation for Full Measurement – Regression Analysis

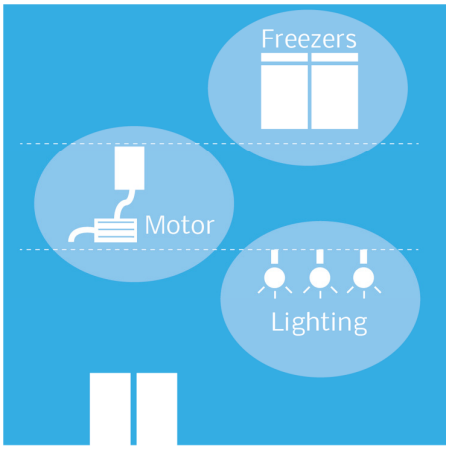
You will need to assess the suitability of each method using the guidance in this section and in Appendix F "Checking the Accuracy of your Baseline".

The next section provides more detailed guidance on the information you have to provide on your baseline which is specific to the M&V approach(es) you have chosen to measure the savings in your project.

For more information on baseline data for:

- Partial measurement approaches see section 2.7.1
- Full measurement – submetering see section 2.7.2
- Full measurement – whole site see section 2.7.3

2.7.1. Partial measurement



The measurement boundary is drawn around the load type affected by the equipment installed, for example the lighting circuits or motors and fridges as shown in the diagram above. Sub-meters or temporary meters can be used to measure savings for each load type of interest. Evidence must be provided for meter calibration. Baseline data will need to be collected and provided for each separate measurement boundary (e.g. if you have two different boundaries baseline and reporting data will need to be collected for each).

Under the partial measurement approach because demand (the load profile) is flat and therefore consistent over time you can take readings before and after implementation for a set period to calculate savings. It may be that the hours of equipment usage changes during the year, for example, longer operating hours over winter, but there shouldn't be significant variation (including seasonal variation) in the level of demand. The time of use during winter peak should be applied to calculate savings using the spreadsheet described below.

Sufficient readings need to be taken to be taken to ensure the readings before and after are sufficiently accurate for calculating savings. The Template Calculation for Partial Measurement spreadsheet allows you to enter your readings and will tell you whether accuracy requirements have been met.

Case Study 1

EDR Project: Replacement of 50 motors on a production line with more efficient models.

The speed of the production line is fixed, so the motors have a constant load profile. The replacement motors will also have a constant load profile.

Measurement Boundary: The boundary was drawn around the motors placed by more efficient models as they could be measured directly using a clamp meter. Conforming with the scheme requirements, a sample size established using the sample size calculator (use the 'Sample size calculator' spreadsheet) of 29 from the 50 motors was taken.

Baseline: Using a calibrated clamp meter, each motor in the sample was measured for 10 seconds.

No. of samples	29
Average demand readings	4 kW
Total no. of fittings	50
Total baseline	200 kW

For this example, the baseline is the average demand of the existing motors multiplied by the number of motors of the same type, i.e. 50 × 4kW = 200 kW. Time of use information (the number of days and hours) are then used to calculate the average kW saving over the peak period. For example if the motors are operational for 41.5 days over the peak period from 4-8pm =100kW average saving value over the peak period.

Case Study 2

EDR Project: Replacement of 2000 lighting fixtures with more efficient LEDs in an office building. The LED fittings will replace two different types of existing fittings - 1600 of type A and 950 of type B.

Measurement Boundary: The light fittings being replaced by more efficient alternatives. Conforming with the scheme requirements, a sample size of 65 was determined for type A, and 63 for type B (see section 9 Sampling for details on calculating sample sizes).

Baseline: Using a calibrated clamp meter, light fittings were measured at random for one second. The lights are used consistently throughout the year and the working day, so readings taken at any time when the lights are in use will be representative of their use during peak hours.

	Type A	Type B
No. of samples	65	63
Average demand readings	80W	60W
Total no. of fittings	1200	800
Baseline	96kW	48kW

For this example, the baseline is the average demand of the existing fittings multiplied by the number of fittings of the same type. The total baseline is (1200 x 80) + (800 x 60) = 144kW

Template Calculation Completion Steps

Guidance for completing the "*Template Calculation for Partial Measurement*"

Create a copy of ***Template Calculation for Partial Measurement*** for **EACH** Measurement Boundary for which you have specified the Partial Measurement approach.

Save the spreadsheet with the naming convention: "Application ID, record category, Boundary Code, ddmmyy" e.g. "GHTT0708-876 baseline B2 030515 "and ensure that the Boundary Codes (B1, B2) correspond with the boundaries in the *"M&V Approach and Boundary"* tab in your M&V Plan Template.

Go to the Baseline tab:

Document your Baseline using the following steps:

Cell ref	Action
B8	Data Source Reference the full name of the data file(s) that you will be submitting with your application and detail where this data has come from e.g. clamp meter readings.
B12	Does the data below correspond to a sample from a wider population?: Enter either ***Yes*** or ***No***. If you are NOT sampling e.g. because you have several sub meters, each sub meter counts as a new boundary and will therefore need a new spread sheet.
B15	How many units in the population?: If ***Yes*** was entered in B12 then enter the number of units that you are representing (e.g. if you are intending to install 50 new motors but will only be taking measurements from 10, your population size will be 50). If ***No*** was entered in B12 then do not fill in B15, B16 or D15. Proceed to F21 to enter the **Data Requirements**
B16	How many units in your sample?: If ***Yes*** was entered in B12 then enter the number of units that the make up the sample (e.g. if you are intending to install 50 new motors but will only be taking measurements from 10, your population size will be 50 and the sample size is 10).
D15	How many units do each of the baseline readings below represent?: Enter the number of units that each measurement represents. This may be the same as your sample size if you are taking multiple readings from the same meter that covers your entire sample. Or it may be that you are measuring each of the units in your sample individually at different points in time e.g. using a clamp meter, in which case this would be 1.

Table continued on next page

Continued from previous page

Cell ref	Action
Data Requirements: You will now need to enter a number of meter readings to ensure you meet the accuracy requirements (this will show as a yes or no at cell F22. If you require more information on accuracy requirements see Appendix F.	
Column A (From A19)	Reading date Enter the dates in the format (dd/mm/yyyy) that you have taken your readings. The number of data points you need to enter will relate to whether or not you meet the accuracy requirement in cell F22. You are able to enter a number of readings for any day or a number of readings over a period of time.
Column B (From B19)	Baseline kW Enter the kW reading for each date from your existing equipment.
F21	Estimated Savings Enter the anticipated kW saving. Where you are using a sample, this should be the kW saving of replacing one unit with the suggested more efficient unit. Where you are not sampling, this should be the estimated kW saving of the unit(s) within the measurement boundary. You should use estimates as per the "*Project detail and peak savings"* tab of your M&V Plan.
F23	Meter relative precision Enter the accuracy of the meter you have used. For example, if your meter has an accuracy of ± 0.01%, you would enter 0.01. Your meter supplier should be able to tell you this and it is checked as part of the calibration process.

Peak Applicability:

You need to complete the table at cell E36 to describe the peak applicability for the entire population of units. It may be that the peak applicability is the same across the population e.g. 100 motors running from 4pm to 7pm, in which case you will only require one line.

However, if you have divided your population up, in order to accurately describe the peak applicability you will need to enter a separate line for each different grouping e.g. 100 motors with 50 running 9am to 7pm and 50 running 9am to 6pm.

Please see below examples.

Examples:

1. You are replacing 100 motors and they are all on between 4pm and 7pm, but off between 7pm and 8pm, Monday to Friday– you will need to complete one line.

Peak Applicable Hours				No. of days applicable across peak period (Nov-Feb)	No. of units each row applies to
4 - 5pm?	5 - 6pm?	6 - 7pm?	7 - 8pm?		
Yes	Yes	Yes	No	83	100

2. You are replacing 100 motors, 50 are on between 4pm and 8pm Monday to Friday and 50 are only on between 4pm and 6pm Monday to Friday – you will need to complete two lines.

Peak Applicable Hours				No. of days applicable across peak period (Nov-Feb)	No. of units each row applies to
4 - 5pm?	5 - 6pm?	6 - 7pm?	7 - 8pm?		
Yes	Yes	Yes	Yes	83	50
Yes	Yes	No	No	83	50

3. You are replacing 100 motors, 50 are on between 4pm and 8pm Monday to Friday and 50 are on between 4pm and 8pm but off on Fridays – you will need to complete two lines.

Peak Applicable Hours				No. of days applicable across peak period (Nov-Feb)	No. of units each row applies to
4 - 5pm?	5 - 6pm?	6 - 7pm?	7 - 8pm?		
Yes	Yes	Yes	Yes	83	50
Yes	Yes	Yes	Yes	66	50

- Peak Applicable Hours – please select 'yes' for those hours when your technology is operational. For hours of partial applicability select 'yes' only if the technology is applicable for the full hour.

- Number of days applicable across the peak period (1 November to 29 February inclusive) – this is the number of days that your stated peak applicable hours are relevant to across the peak (business days, Nov – Feb inclusive (this is Monday to Friday excluding bank holidays) and will default to 83 days (100%). You may not enter a number higher than 83 (even if you operate on bank holidays or weekends). You may however, enter a number lower than 83. Examples are:
    - We close for 2 weeks in December (reduce by 10 days) = 73
    - We don't work Fridays (reduce by 17 days) = 66

Check your result:

The spreadsheet will calculate the accuracy as described in Appendix F and report either *a "yes" or "no"* in cell F22 to indicate whether the accuracy requirement has been met.

- If "yes", you should save the spreadsheet and attach as part of your submission (see M&V Plan completion steps at the end of this section).
- If "no" see the FAQs for tips on improving accuracy – this may involve adding more meter reading, or may mean you are unable to use partial measurement and need to assess the other methodologies.

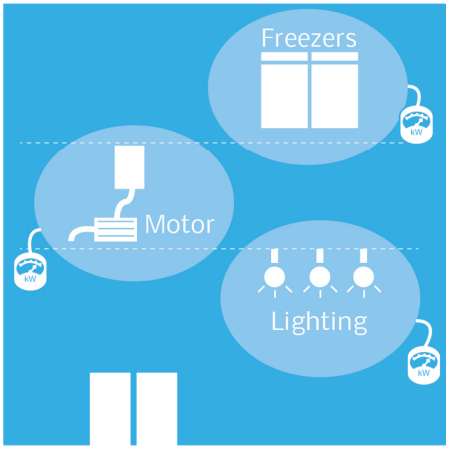
Note that the template also contains a “Reporting” sheet, which is intended to be used when the equipment is installed in order to measure savings and is the basis for the reporting and payment under the pilot. (i.e. after the measures are installed and enough time has elapsed – see section 3 ‘Post Installation Activities’ for further details).

Partial Measurement Baseline Checklist

Take demand readings of your equipment.

- Record demand readings of the existing technology using the “Template Calculation for Partial Measurement” spreadsheet.
- To note you will also need to monitor time of use over the winter peak period 2015/16 so you can accurately report and calculate savings.
- Submit your spreadsheet as part of your application.

2.7.2. Full Measurement: Submetering



Measurement boundary is drawn around the submeter(s) used to capture the effect of the equipment being installed..

Baseline and reporting information will need to be provided for each separate boundary. For example in the image above lighting, motors and freezers have their own submeters. Baseline and reporting data would need to collected for each boundary (a total of 3) to measure and verify savings at the site.

For this approach, the baseline will be either:

- An average value for peak relevant kWh consumption, established from the submetering and requiring no adjustment. This will be the case if the electricity consumption of the equipment you are measuring does not vary substantially. This may be because it is not sensitive to changes in external temperature, or because operating conditions are very consistent. Please use the **Template Calculation for Full Measurement – Average Readings** to complete your baseline.
- An adjusted baseline, that accounts for changes in independent variables. This will be the case if the baseline captures a range of operating conditions, or is sensitive to external temperature. As described in section 2.6.1.1, adjustments can be either routine or non-routine and require consideration as to whether they are appropriate. Please use the **Template Calculation for Full Measurement – Regression Analysis** to complete your baseline.

Note that the baseline period should be representative of demand during the winter peak 2013/14, either by using data directly from this period, which is essential where there is seasonal variation, or data that represents the most recent full cycle from the past year. This will be compared against data that is representative of demand during the winter peak 2015/16.

Choosing between Average Readings or Regression Analysis (adjusted baseline):

Average Readings

If you are not sure whether adjustments are required, the Template Calculation for Full Measurement – Average Readings can be used to establish whether a simple average is accurate enough. By entering in your baseline peak relevant kW or kWh readings and the expected savings, the spreadsheet will calculate the accuracy.

Regression Analysis

If a simple average is not accurate enough, the "Template Calculation for Full Measurement – Regression Analysis" spreadsheet can be used instead to test whether adding a routine adjustment improves the accuracy of the baseline.

The template for regression analysis allows you to input kW or kWh readings recorded over peak hours along with independent variable data that would allow you to calculate routine adjustments. The accuracy of the resulting baseline adjustments are calculated by the template spreadsheet.

Routine Adjustments

As a starting point to determine relevant independent variables, you should consider what is likely to cause variations in demand for the load that you are isolating. For example:

- Does the load affect space heating? If so, demand may be influenced changes in external temperature this could be used as an independent variable using publically available data[1].

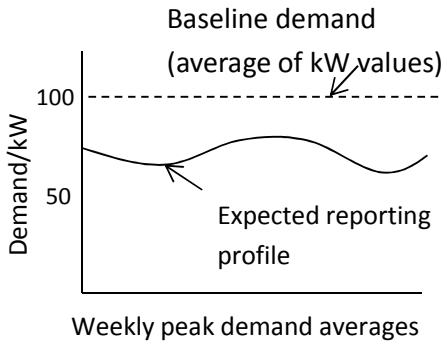
Case Study 1

EDR Project: Installation of variable speed drives for a production process.
The demand of the existing motors is constant, but full measurement is required because the demand with the variable speed drives installed will not be.

Measurement Boundary: The production lines on which the drives are installed; kWh consumption data is recorded by a submeter installed on the line, taking readings every half hour.

Baseline: The average peak relevant kW was calculated from the associated kWh weekly totals recorded over peak hours. The baseline is the average of weekly kW peak demand values, and reporting period data will be compared to this.

Whilst there is variation in electricity usage expected once the variable speed drives are installed, this is not relevant for the calculation of the baseline.



[1] http://www.degreedays.net/

Non-routine Adjustments

If you think it is likely that you will need to apply non-routine adjustment further guidance is provided under “Non-Routine Adjustments” in section 2.7.3 ‘Full Measurement - Total Building Electricity.

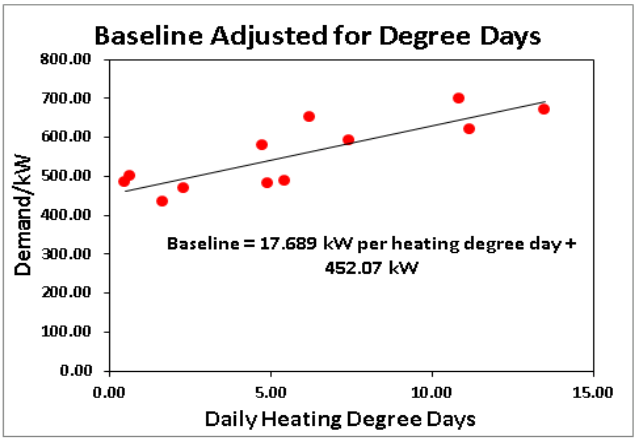
Case Study 2

EDR Project: Replacement an Air Handling Unit (AHU) in a large retail centre.
The demand of the existing AHU system varies with external temperature, and will also vary with temperature once the new system is installed.

Measurement Boundary: The boundary is drawn around the AHU system – kWh consumption data is recorded by a submeter installed on the system, taking readings every half hour.

Baseline: The average peak relevant kW was calculated from the associated kWh monthly totals recorded over peak hours. The demand of the existing equipment varies with external temperature, so the baseline is adjusted using heating degree days using a regression analysis (see section 4.4.2 for further details of how to do this). Due to variation with external temperature, a calendar year provides a full cycle of consumption.

Month	Peak Demand kW	Daily Degree Days
January	668.14	13.52
February	698.14	10.86
March	589.32	7.45
April	487.46	5.43
May	479.79	4.94
June	433.35	1.67
July	498.19	0.65
August	483.17	0.48
September	468.56	2.30
October	576.91	4.74
November	649.91	6.23
December	620.02	11.16



The baseline is 17.69 kW per heating degree day + 452.07 kW

Template Calculation Completion Steps

Guidance for completing the "*Template Calculation for Full Measurement – Average Readings*"

For both of the Full Measurement approaches you have the choice of either using the Average Readings Spreadsheet or the Regression Spreadsheet. If you are aware that an external factor impacts your demand values you should go straight to the instructions for completing the *"Template Calculation for Full Measurement: Regression Analysis"* spreadsheet. However if you are either: confident that you will meet the accuracy requirements by using a simple average; or you are uncertain which approach you need to use, we suggest you complete the ***"Template Calculation for Full Measurement - Average Readings"*** to document your baseline. You will then need to ensure that you have met the accuracy requirements.

Go to the Data BL tab:

Please enter your meter data in this tab to cover the entire baseline period as defined in your "M&V Approach and Boundary" tab. Ensure you use the format as shown

Go to the Baseline tab:

Document your baseline using the following steps:

Cell ref.	Action
B8	Data Source: Reference the full name of the data file(s) that you will be submitting with your application and detail where this data has come from e.g. HH meter, submeter etc.
B10	M&V Approach: Select either Full Measurement: Total Building Electricity **or** Full Measurement: Submetering
B13	Does the data below correspond to a sample from a wider population?: Enter either ***Yes*** or ***No***. Please note that if you are not sampling e.g. because you have several submeters, each submeter counts as a new boundary and will therefore need a new spreadsheet.
B16	How many units are in the population?: If ***Yes*** was entered in B13 then enter the number of units that you are representing (e.g. if you are intending to install 50 new motors but will only be taking measurements from 10, your population size will be 50). If ***No*** in B13 then do not fill in B17, Proceed to enter the **Data Requirements**

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Cell ref.	Action
B17	How many units are in your sample?: If ***Yes*** was entered in B13 then enter the number of units that the sample size (e.g. if you are intending to install 50 new motors but will only be taking measurements from 10, your population size will be 50 and the sample size is 10).
D16	How many units do each of the baseline measurements below represent?: Enter the number of units that each measurement represents. This may be the same as your sample size if you are taking multiple readings from the same meter that covers your entire sample. Or it may be that you are measuring each of the units in your sample individually at different points in time e.g. using a clamp meter, in which case this would be one.
Data Requirements: You will now need to enter a number of meter readings to ensure you meet the accuracy requirements (this will show as a yes or no at cell H27). If you require more information on accuracy requirements see Appendix F. You can select a suitable time period between entries. However, please note, the longest period between entries should be a week (i.e. the kWh values would be calculated by summing the half hourly data for 4 – 8pm Monday to Friday) and the shortest period should be a day (i.e. the total kWh from 4 – 8pm for each respective weekday).	
Column A From A23	Start Date: Enter the start date of the period (dd/mm/yyyy)
Column B From B23	End Date: Enter the end date of the period (dd/mm/yyyy)
H23	Are readings kW or kWh?: Select either kWh or kW (to indicate the unit of measure of the raw data)
Column C From C22	Baseline: If you have selected kWh in H22 - enter the sum of kWh recorded over peak hours (4pm-8pm) for the defined period If you have selected kW in H22 - enter the average kW value recorded over peak hours (4pm-8pm) for the defined period.
H26	Estimated kW Savings: Where you are using a sample, enter the anticipated saving of replacing one unit with the suggested more efficient unit. Where you are not using a sample, enter the expected saving of the equipment in the measurement boundary. You should use estimates as per the “Project detail and peak savings” tab of your M&V Plan.

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Cell ref.	Action
H28	Meter relative precision: Enter the accuracy of the meter you have used. For example, if your meter has an accuracy of ± 0.01%, you would enter 0.01. Your meter supplier should be able to tell you this and it is checked as part of the calibration process.

Check your result:

The spreadsheet will calculate the accuracy as described in Appendix F and report either "yes" or "no" in cell H27 to indicate whether the accuracy requirement has been met.

If "yes":

- Save the spreadsheet with the naming convention: "Application ID, record category, Boundary Code, ddmmyy" e.g. "GHTT0708-876 baseline B2 030515 "and ensure that the Boundary Codes (B1, B2) correspond with the boundaries in the *"M&V Approach and Boundary"* tab in your M&V Plan Template.

If "no":

- You may need to add more data points (either by using a longer period or by improving the resolution of your readings by using daily rather than weekly peak kWh totals) to try and improve accuracy or you will need to use the Regression model as there is too much variation in your data.

Template Calculation Completion Steps

Guidance for completing the "*Template Calculation for Full Measurement – Regression Analysis*"

If a simple average is not accurate enough (from attempting to use the Template Calculation for Full Measurement – Average Readings spreadsheet and being unable to meet the accuracy requirement) or you are aware that an external factor(s) impacts your demand values, the ***"Template Calculation for Full Measurement – Regression Analysis"*** will test whether routine adjustments improve the accuracy of the baseline.

Please note that the Regression Analysis template only allows for a simple Regression (one independent variable), if you require a multiple regression (more than one independent variable) please contact DECC to discuss how you will need to submit this edr-project@decc.gsi.gov.uk**.**

Go to the Data BL tab:

Please enter your meter data in this tab to cover the entire baseline period as defined in your "M&V Approach and Boundary" tab. Ensure you use the format as shown.

Go to the Baseline tab:

Document your baseline using the following steps:

Cell ref	Action
B8	Demand Data Source: Reference the full name of the data file(s) that you will be submitting with your application and detail where this data has come from e.g. HH meter, submeter etc.
B11	M&V Approach: Select either Full Measurement: Total Building Electricity **or** Full Measurement: Submetering
B14	Independent Variable: Name the independent variable you are using e.g. Heating Degree Days
B17	Independent Variable Data Source Detail the independent variables and their source e.g. heating degree days from Heathrow airport, base temperature 15.5C, occupancy records from swipe card building access data. This should be attached to your submission.
B23	Does the data below correspond to a sample from a wider population?: Enter either ***Yes*** or ***No***. Please note that if you are not sampling e.g. because you have several submeters, each submeter counts as a new boundary and will therefore need a new spreadsheet.
B26	How many units are in the population? If ***Yes*** was entered in B23 then enter the number of units that you are representing (e.g. if you are intending to install 50 new meters but will only be taking measurements from 10, your population size will be 50). If ***No*** in B23 then do not fill in B26, Proceed to enter the **Data Requirements**
B27	How many units are in your sample?: If ***Yes*** was entered in B23 then enter the number of units that the sample size (e.g. if you are intending to install 50 new meters but will only be taking measurements from 10, your population size will be 50 and the sample size is 10).
Table continued on next page	

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Cell ref	Action
Data Requirements: You will now need to enter a number of meter readings to ensure you meet the accuracy requirements (this will show as a yes or no at cell J38. If you require more information on accuracy requirements see Appendix F. You can select a suitable time period between entries. However, please note, the longest period between entries should be a week (i.e. the kWh values would be calculated by summing the half hourly data for 4 – 8pm Monday to Friday) and the shortest period should be a day (i.e. the total kWh from 4 – 8pm for each respective weekday).	
Column A From A32	Start Date: Enter the start date of the period (dd/mm/yyyy)
Column B From B32	End Date: Enter the end date of the period (dd/mm/yyyy)
J32	Are readings kW or kWh?: Select either kWh or kW (to indicate the unit of measure of the raw data)
Column C From C32	Baseline: If kWh entered in J32 – enter the sum of kWh recorded over peak hours (4pm-8pm) for the defined period If kW entered in J32 - enter the average kW value recorded over peak hours (4pm-8pm) for the defined period
Column D From D32	Independent Variable: Enter the values for the independent variable you are using. The units here are irrelevant as long as they are consistent throughout.
J37	Estimated kW saving: You should enter your expected kW reduction for the equipment in the measurement boundary so that the accuracy can be assessed.
J39	Meter Relative Precision: Enter the accuracy of the meter you have used. For example, if your meter has an accuracy of ± 0.01%, you would enter 0.01. Your meter supplier should be able to tell you this and it is checked as part of the calibration process

The spreadsheet will calculate the accuracy as described in Appendix F and report either "yes" or "no" in J38 to indicate whether the accuracy requirement has been met.

- If "yes":
- Save the spreadsheet with the naming convention: "Application ID, record category, Boundary Code, ddmmyy" e.g. "GHTT0708-876 baseline B2 030515 "and ensure that the Boundary Codes (B1, B2) correspond with the boundaries in the *"M&V Approach and Boundary"* tab in your M&V Plan Template.
- If "no":

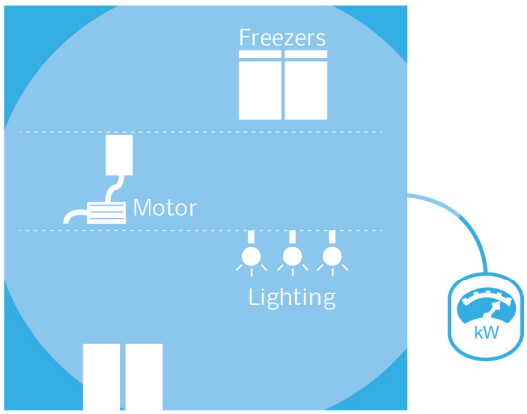
  Please see the Appendix D - FAQs on how to improve your baseline average.

Note that both Full Measurement templates also contain a "Reporting" sheet, which is intended to be used once the demand reduction measures are installed in order to measure savings and on which the schemes' reporting and payments are made (i.e. after the measures are installed and enough time has elapsed – see section 3.2 for further details).

Full Measurement: Submetering Checklist

- Identify the submeter(s) you have used to record energy usage and extract the energy data for peak applicable hours.
- Calculate your baseline and any adjustments using either the "Template for Full Measurement – Average Readings" or the "Template for Full Measurement – Regression Analysis" spreadsheet.
- Submit your spreadsheet as part of your application.

2.7.3. Full Measurement: Total Building Electricity



Measurement boundary is drawn around the total site electricity consumption. Electricity from the grid will be captured by your utility meter and available from the electricity supplier, usually at half hourly intervals. If existing on-site generation is used, you should identify this and document how data from this is captured.

Baseline data will need to be collected and provided for each separate site where this approach is used e.g. if you had two different sites using this approach you would have to provide baseline and reporting data for two sites.

For the total electricity use of a building (grid + onsite generation as appropriate) a baseline for peak demand will be either:

- An average value for peak relevant kWh consumption, established from the total electricity consumption and requiring no adjustment. This will be the case if the electricity consumption of the building you are measuring does not vary substantially. This may be because it is not sensitive to changes in external temperature (i.e. no electric heating or cooling), and if operating conditions are very consistent. Please use the **Template Calculation for Full Measurement – Average Readings** to complete your baseline.
- An adjusted baseline, that accounts for changes in independent variables. This will be the case if the baseline captures a range of operating conditions, or is sensitive to external temperature. As described in section 2.6.1.1, adjustments can be either routine or non-routine and require consideration as to whether they are appropriate. Please use the **Template Calculation for Full Measurement – Regression Analysis** to complete your baseline.

Note that the baseline period should be representative of demand during the winter peak 2013/14, either by using data directly from this period, which is essential where there is seasonal variation, or data that represents the most recent full cycle from the past year. This will be compared against data that is representative of demand during the winter peak 2015/16.

Choosing between Average Readings or Regression Analysis (adjusted baseline):

Average Readings

As with Full Measurement: Submetering, you can test whether a simple average is suitable using the Template Calculation for Full Measurement – Average. By entering in your baseline peak relevant kW or kWh readings and the expected savings, the spreadsheet will calculate the accuracy.

Regression Analysis

If a simple average is not accurate enough, the Template Calculation for Full Measurement – Regression Analysis can be used instead to test whether adding a routine adjustment improves the accuracy of the baseline.

The template for regression analysis allows you to input kW or kWh readings recorded over peak hours along with independent variable data that would allow you to calculate routine adjustments. The accuracy of the resulting baseline adjustments are calculated by the template spreadsheet.

For Full Measurement - Total Building Electricity it is more likely that you will need to consider adjustments to account for factors affecting demand. Examples include weather, building occupancy or production volumes. Taking these into account would aim to allow you to measure the change in demand resulting from the EDR project more accurately than a simple comparison of raw data

Routine Adjustments

As a starting point to determine relevant independent variables, you should consider what is likely to cause changes in the overall electricity consumption in your building and what data is available to quantify the variable. Common examples are as follows:

- External temperature: information is widely published for regions of the UK and publically available[2]
- Daylight hours: information is published publically for all areas of the UK[3]
- Production volumes: information and data capture is site specific, but typically include total production numbers for product type over a set period of time (e.g. weekly or monthly).
- Building occupancy: information and data capture is site specific, but can be captured via building access records (e.g. swipe card data), or other proxy such as sales data for retail or hospitality sectors.

Once you have identified and obtained data for independent variables, these can be entered along with the associated peak demand or kWh readings into the “Template Calculation for Full Measurement – Regression Analysis”. This will enable you to test whether the independent variable data is relevant as described in Appendix F.

The period chosen for your baseline should capture the most recent full cycle of electricity use for the building. The length of time required for a full cycle of consumption will be determined by the nature of the independent variables. Use of any seasonal variables in a regression model would require baseline data for a full calendar year because a full year will provide a more

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[2] http://www.degreedays.net/

[3] http://www.timeanddate.com/worldclock/

rigorous baseline (a more in-depth explanation of this is included in the FAQs). For buildings without weather sensitive electricity demand, a shorter period may represent a full cycle.

A worked example that uses regression analysis to calculate a baseline is appended to the manual.

Non-Routine Adjustments

Measuring demand reduction at the total building level means that any changes that are *not* related to the equipment will be captured within the measurement boundary. These changes can be taken into account using non-routine adjustments to the baseline and recorded under the "Baseline" sheets of your M&V Plan.

It is worth noting that if there are numerous changes happening in the building at the same time this is likely to add complexity to the measurement process. As far as possible, the on-going project management of the EDR project should seek to reduce the need for non-routine adjustments.

How non-routine adjustments are accounted for will depend on the nature of the change in load, examples of common scenarios are below.

- **Additional Electrical Equipment**
  You will need to identify the source of the additional load and use a monitoring instrument to measure the demand. If the additional load is constant, the time of use of the load can either be measured by the same instrument, or estimated in order to find the change in peak relevant kW demand or total kWh consumption. The resulting increase in demand can be taken into account in the reporting period so that demand is compared fairly. If the increase in load is variable, then the monitoring instrument would be required to record electricity use continuously (as achieved using a submeter, for example).
- **Change to Operating Hours**
  If changes to the operating hours of a building occur (specifically those relevant to during peak hours), you will need to calculate and document the resulting impact on demand. Changes in electricity consumption could be measured by submetering of the loads affected by operating hours, for example lighting or space heating. Whilst this would represent the most accurate approach, it is not always practical to implement. An alternative approach would be to estimate changes from building load profiles as captured by interval meter data.

You will also need to establish if the non-routine adjustment caused by the change in load is permanent or temporary. Since the change in load is unrelated to the equipment, this will affect the reporting of savings, particularly if the change is temporary.

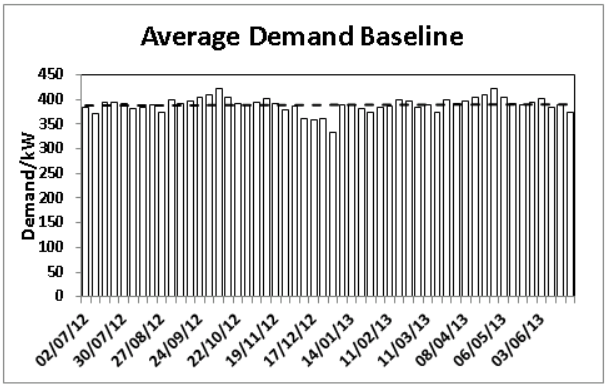
As part of this plan, you will have assigned responsibilities for M&V, and this should include the process for monitoring the need for non-routine adjustments.

Case Study 1

EDR Project: Multi-technology building retrofit including lighting replacement and controls, air handling unit upgrade, pump upgrades.

Measurement Boundary: Total building; electricity consumption taken from utility half hourly data.

Baseline: The average peak relevant kW was calculated from the associated kWh weekly totals recorded over peak hours. There was no significant variation with external temperature, and the average demand was accurate enough to provide a baseline kW figure (see Appendix F on calculating the accuracy average demand values).



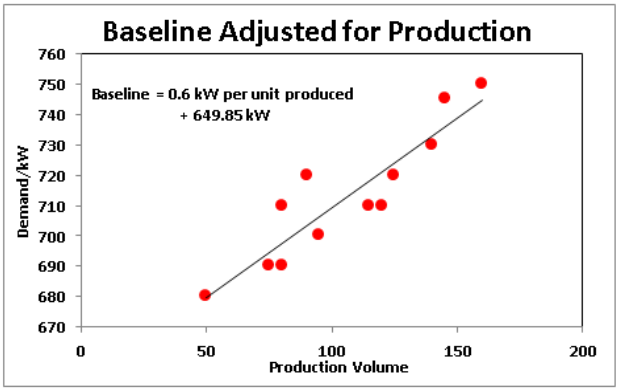
Case Study 2

EDR Project: Upgrade of drives and controls in a production plant, expected to exceed 10% of total electricity use.

Measurement Boundary: Total building electricity consumption, taken from utility half hourly data.

Baseline: The average peak relevant kW was calculated from the associated kWh monthly totals recorded over peak hours. The demand of the existing equipment varies with production volumes, so the baseline is adjusted using the total number of units produced for each month of the previous year using a regression analysis. A full calendar year provides a full range of expected production volumes.

Month	Weekday kW demand from 4 - 8pm	Production Volume
October	710	120
November	690	80
December	720	125
January	700	95
February	710	115
March	750	160
April	730	140
May	680	50
June	690	75
July	745	145
August	720	90
September	710	80



The baseline is 0.6kW per unit produced + 649.85kW.

Completing the "*Template Calculation for Full Measurement – Average Readings*"

Follow the instructions at 'Template calculation completion steps' outlined in the previous section (section 2.7.2 'Full Measurement – submetering'.

Completing the "*Template Calculation for Full Measurement – Regression Analysis*"

Follow the instructions at 'Template calculation completion steps' outlined in the previous section (section 2.7.2 'Full Measurement – submetering'.

Note that both Full Measurement templates also contain a "Reporting" sheet, which is intended to be used once the demand reduction measures are installed in order to measure savings and on which the schemes' reporting and payments are made (i.e. after the measures are installed and enough time has elapsed – see section 3.2 for further details).

Full Measurement: Total Building Electricity Checklist

- Identify the data that you will need for your baseline – this should be utility half hourly meter data and any data from onsite generation.
- Calculate your baseline and any adjustments using either the "Template for Full Measurement – Average Readings" or the "Template for Full Measurement – Regression Analysis" spreadsheet.
- Submit your spreadsheet as part of your application.

M&V Plan Completion Steps

For each of your measurement boundaries you will need to create a copy of the relevant Template Calculation Spreadsheet to document the baseline associated with each boundary. You should use the following the naming convention:

"Application ID, record category, description of file, ddmmyy"

e.g. "GHTT0708-876 baseline B2 030515"

Make sure your boundary label matches up with the boundaries as set out in your M&V Plan Template.

Use one of the following three spreadsheets to calculate your baseline (and repeat for each baseline as required):

- Template Calculation for Partial Measurement
- Template Calculation for Full Measurement – Average Readings
- Template Calculation for Full Measurement – Regression Analysis

Note that the three templates above for baseline calculations contain a "Reporting" tab, which is intended for use once your measures have been installed. Your baselines calculated using these templates should therefore be retained in order to report savings (see section 3 Post Installation Activities for further detail).

Example: if you have six measurement boundaries in your project you would have to provide six separate template calculation spreadsheets with the relevant baseline data included. You do not need to embed these into the 'Baseline' tab of the M&V template but instead should save each file separately using the naming convention above and send the files as attachments to your plan.

Please ensure that for all evidence files you follow the naming convention:

Application ID, record category, boundary code, ddmmyy

e.g. **GHTT0708-876 Baseline B1, 030515**

End of Section Checklist

- Choose a suitable baseline period for your project as described above.
- Decide if any adjustments to the baseline are required – these could be either routine or non-routine. You need to have identified any routine adjustments when submitting your plan. They should not be applied retrospectively.
- Record this information in the "baseline" sheet of the template M&V Plan. This will include:
  - The baseline demand or energy data
  - The dates used to calculate it
  - Any adjustments to the data to account for variations in energy use
  - Associated accuracy calculations [see Appendix F for more information on this]

Section summary: M&V approach, boundary & baseline

REQUIREMENT

You are required to describe the M&V approach(es) and associated measurement boundaries that you will use to verify and measure the savings from your project.

DESCRIPTION

Given the 100kW average peak relevant saving minimum project size it may be that you will need to use more than one M&V approach to measure the savings in your project. You may have multiple measurement boundaries. You must choose from four alternative approaches to measurement and verification and, if using an approach that requires the collection of metered data, you will need to:

- define the measurement boundary and:
- provide details of your baseline (length and adjustments if required)
- collect the required metered data and data on other variables where relevant

M&V APPROACHES

There are a total of four M&V approaches to choose from:
Deemed savings – spreadsheet calculators are used to calculate savings, only technologies on the list can be deemed.
More complex projects will use one of three approaches involving a meter to measure savings:

- Partial measurement
- Full measurement: Submetering
- Full measurement: Total Building Electricity

A decision is tree is provided to help you choose the right approach for each site included in your project.

WHAT YOU HAVE TO DO

Fill out the 'M&V approach and boundary' tab of the M&V template.
For each site included in your bid you will need to:

- select the most appropriate M&V method(s) to measure savings
- define the measurement boundary(ies) attached to each approach
- for each measurement boundary provide details of and data for the baseline

EVIDENCE REQUIREMENTS

Provide baseline data and any additional data as required (e.g. data to adjust the baseline).

EXAMPLE

Project A has 8 sites. Retail display cabinets are being replaced at all 8 sites. At site 7 the HVAC system and pumps are upgraded and savings are expected to be greater than 10% of total electricity use at the site so they choose to use a whole site metered approach for this site. Deemed calculators and site meter data for site 7 are used to measure and verify the savings of the project.

3. Post installation Activities

3.1. Reporting Operational Verification

Section overview

The purpose of this section is to:

- Provide guidance on the post-installation requirements for operational verification.
- Provide guidance on the evidence requirements to report and verify your project's savings. This will need to be submitted by 15 October 2015.

When installing measures you will need to ensure that the processes and procedures you outlined for Operational Verification in your M&V Plan are followed and that you are able to provide the stated evidence by 15 October 2015 to verify that the activities have taken place.

Evidence to demonstrate the purchase and installation of your measures should include:

- Receipts/proof of purchase of equipment, which should be dated on or after the signing of the Participant Agreement; and
- Evidence of completed Operational Verification activities, for example a Commissioning certificate. The evidence must include the following as a minimum:
  - Registered company name and address, and site address where the equipment was installed
  - A full list of the equipment installed, matching the original quotation, with date of installation
  - The customer's printed name and signature, on behalf of their company
  - The equipment supplier's name and address
  - The installation engineer's printed name and signature

For each technology type included in your bid you will need to provide evidence of Operational Verification (OV) activities carried out. Where supplier guidance indicates that different OV activities should be carried out within the same technology type details of operational verification activities for each separate process should be provided. For example, if a firm is installing five motors at one site all of which involve the same OV procedures then providing evidence on the single procedure would be acceptable. If however the OV activities varied between the motors (e.g. one motor follows a different process) then separate OV evidence needs to be supplied for the four motors using one approach and the fifth motor using another

approach. You will need to make it clear which parts of your project the OV evidence relates to (site references and equipment types) so that it is clear all the equipment covered in your project. You may want to consolidate the evidence in a single file with a cover sheet to reference explaining the OV evidence if easier.

TO NOTE FOR DEEMED APPROACHES YOU SHOULD PROVIDE DETAILS OF OPERATIONAL VERIFICATION EVIDENCE IN THE DEEMED SPREADSHEETS, NOT THE MAIN M&V TEMPLATE.

3.1.1. Evidence

Evidence will need to be provided for each technology type included in your bid and, if the OV procedure varies within the same technology type, for each different process.

Please ensure that for all evidence files you follow the naming convention:

Application ID, record category, description of file, ddmmyy

E.g. **GHTT0708-876 OV equipment receipts 030515**

The nature of the evidence you provide will be dependent on the type of technologies that you are installing but should at a minimum include the following:

a) Receipts/proof of purchase of equipment – these must dated on or after signing of the Participant Agreement; and

b) Commissioning certificate – which should include the following as a minimum:

- Registered company name and address, and site address where the equipment was installed
- A full list of the equipment installed with date of installation
- The customer's printed name and signature, on behalf of their company
- The equipment supplier's name and address
- The installation engineer's printed name and signature

Section 5 of the Participant Handbook provides further information on what happens in the event that this requirement is or isn't met. Where possible it would be preferable if you could consolidate your evidence submissions e.g. putting all the OV evidence into one file with a coversheet that references the evidence would be preferable to avoid too many attachments.

☑ **End of Section Checklist**

- You are required to carry out the operational verification activities and provide the relevant evidence as set out in your M&V plan by 15 October 2015.
- This should include as a minimum:
  - invoices to verify purchase of the equipment
  - commissioning certificates
  - you should also make sure you make it clear how the evidence supplied relates to the equipment in your project so that it is clear it is all covered. You may want to use a cover sheet for this.
- Please use the following naming convention for saving files:
  - Application ID, record category, description of file, ddmmyy
  - E.g. **GHTT0708-876 OV site 4 commissioning 030515**
  - E.g. **GHTT0708-876 OV pump commissioning certificate 030515**

3.2. Reporting Savings from Your Project

Section overview

The purpose of this section is to:

- Explain reporting requirements you need to comply with

Using the guidance in this section, you should use the template M&V Plan to:

- Confirm the actual time of use of your equipment over the winter peak 2015/16 period
- If using a metered approach report the demand savings resulting from your project as set out in the "Report" sheet each of the boundaries included in your project (see the previous section for more information on baselines).
- Provide a Winter Capacity Savings Report between 1 March and 15 April 2016 (80% of payment is linked to this) and a Final Report by 1 December 2016 (20% of payment is linked to this).

3.2.1. Reporting requirements

Following implementation, there are two reporting milestones to which payments are attached. Section 6 (pg. 40) of the Participant Handbook sets out more detail, the two milestones are:

- **A Winter Capacity Savings Report (WCSR)** which must be submitted to DECC between 1 March and 15 April 2016. Up to 80% of payment is contingent on this report, it will include:
    - confirmation of the actual time of use of the equipment installed over the winter peak period 2015/16; and
    - for those using metered approaches document the demand reduction in kW over the winter peak November 2015 – February 2016. Your report should be prepared once data that is representative of electricity use over the winter peak is available and submitted by completing the "Reporting" tab in the boundary spreadsheets as created in the baseline section and the "Report Total" tab of your original M&V Plan.
    - for deemed approaches reporting will involve confirmation of time of use over the 2015/16 winter peak and the provision of operational verification evidence and receipts only (where not already supplied).

- **A Final Report** – to be completed by 1 December 2016. The remaining 20% of payment is contingent on this report and participation in evaluation activities (where participants are selected for evaluation). If using a full metered approach this may involve the provision of additional metered data or if using a deemed or partial measurement approach it may involve the participation in evaluation activities. Further detail on the Final Report is provided in section 7 of the Handbook, the key information requirement is summarised in the table below. An outline Final Report template will be provided in due course.

	Deemed schemes	**Metered – whole building approach**	**Sub-metered – operating cycle > 4 months**	**Sub-metered – operating cycle equal to or < 4 months**	**Partial metering**
Data requirement at Final Report stage	No further requirement	• 12 months of meter data • 12 months data series for any independent variable • Information on any anomalies for example significant unusual production outages If it is not feasible to provide this data please discuss with DECC		Where possible, please provide data as requested for other metered projects *Where data can be provided it will add a valuable component to our ability to evaluate the performance of the pilot*	
Other requirement	Participation in evaluation activities and completion of Evaluation questionnaire				
Earliest date of Final Report	8 weeks post-submission of WCSR	Dependent on installation date and date WCSR is submitted, for example: • 27 April 2016 if installed by 26 April 2015 and WCSR submitted 1 March 2016; • 10 June 2016 if installed by 9 June 2015 and WCSR submitted by 15 April 2016; or • 31 October 2016 if installed by 30 October 2015 (WCSR submitted by 15 April 2016).			

3.2.2. Winter Capacity Savings Report

Confirming actual time of use

As part of the Winter Capacity Savings Report, all projects (including those using deemed approaches) will be required to confirm the time of use of their equipment over the winter 2015/16 peak, and whether this has changed from the expected time of use submitted at the time of the auction. You should use the 'Winter peak use' tab of the M&V template for this purpose. You should use the yellow text box at the top to describe if any changes have occurred and provide a more detailed breakdown, if it is needed, as follows:

For deemed approaches:

- if you are using a deemed approach and time of use varied from the expected time of use set out at the time of the auction you will need to re-complete the relevant deemed spreadsheet(s) calculators with the updated time of use to calculate the savings achieved from your project. If there were no changes in time of use you must confirm that the operating hours were as set out in your original submission in this yellow box on the 'Winter Peak use' tab. Your payment will be based on the confirmed time of use information and operational verification evidence you provide. As with all M&V approaches where time of use changes result in a reduction in the average capacity saving achieved over the winter peak period this will result in reduced payments.

For partial measurement approaches:

- you will need to input the actual time of use as part of the 'Template Calculation for Partial Measurement' reporting section of the spreadsheet
- you should describe any changes in time of use compared to the expected time of use in the 'Winter peak use' tab and, if necessary, provide a breakdown of the changes by copying over the expected time of use from the 'Project detail and peak saving tab' highlighting any changes in time of use.

For full measurement approaches:

- if there were no changes and the equipment operated as intended you can simply copy across your spreadsheet 'Project detail and peak savings' tab and confirm the operating hours were as expected.
- where there were changes in the times of use of equipment compared to that expected you will need to copy across the expected times of use of equipment in your project from the 'Project detail and peak savings' tab and highlight those tabs where time of use changed.

For both full and partial measurement approaches you will also need to provide your metered data, any data for independent variables and complete the relevant reporting sheets for your measurement boundaries (see the next section).

Data reporting (for those using M&V approaches involving the use of metering)

If you are using a metered M&V approach, as you have already done for your baseline period, for the reporting period you will need to:

- collect raw metered data over the reporting period in half-hourly format. Partial measurement approaches using manual application of clamp meters may be able to provide data in a different format (e.g. less than half hourly).
- extract the peak relevant kWh or kW savings over the peak period from the raw data and input this into the reporting tab of the M&V approach you have chosen to measure savings. This will be used to calculate the average peak kW savings. You will also need to attach your raw metered data for the whole period (i.e. not just the peak period but the full data). This is so it is possible to verify the savings figures used.

The period of time and the exact reporting process will be dependent on the M&V approach, as described below:

M&V Approach	Reporting Process
Partial Measurement	As there is no seasonal variation in demand, reporting can be carried out as soon as the new equipment is in place and operating as it will be during peak relevant hours. Using the same metering process to measure the baseline, you will need to take demand readings of the new equipment and enter the readings into the “Reporting” sheet of the template for average demand readings. You should take a similar number of readings to those used for the baseline. Any change in the peak relevant hours should be documented when reporting savings, including evidence of the change, as provided for the original hours of operation. The template for average demand readings will calculate the reduction in demand, which should be included in the template report of the M&V Plan. See the ‘M&V completion’ steps at the end of this section for instructions on how to fill out the template.

Example

Consider the lighting example from Case Study 2 in 2.7.1Partial Measurement. The project involved the replacement of 2000 lighting fixtures with more efficient LEDs in an office building. The LED fittings replace two different types of existing fittings - 1600 of type A and 950 of type B. To calculate the baseline, a sample of each type of light fitting was measured.

Once the LED fittings have been installed, a sample should be measured to calculate the new demand (Appendix G provides more information on sampling). From the total of 2000 fittings, a sample of 68 would meet the accuracy requirements for the sample size. As use of the lighting is consistent throughout the year during the working day in this case, measurements taken at any time when the lights are on will be representative of their use during peak hours.

For this case, a savings report can be prepared once measurements have been taken of the new lighting.

M&V Approach	Reporting Process
Full Measurement: Submetering or Total Building	Reporting can be carried out once a full cycle of consumption has elapsed. As described in section 2.7, the duration of a full cycle is dependent on the operating conditions of the equipment or building being measured. Where seasonal variables have been used to calculate adjustments, a full winter peak will need to elapse before savings can be measured and reported for the peak months. Where other variables are used, shorter periods are acceptable provided that a range of typical operating conditions is captured. Data should be captured using the same metering used to calculate the electricity baseline, i.e. either a submeter, or a utility meter for the whole building. If the baseline is an average value, then the new average value with EDR project implemented should be compared to the original. The spreadsheet template for average demand readings has a “Reporting” sheet where readings can be entered once the project has been implemented. Where adjustments have been calculated from a regression analysis, the reporting period data will need to be compared to the adjusted baseline data. The template spreadsheet for regression analysis has a “Reporting” sheet, allowing electricity and variable data to be entered. See the ‘M&V completion’ steps at the end of this section for instructions on how to fill out the template.

Where your project has more than one measurement boundary (e.g. multiple sites or technologies) you will need to report the saving of each boundary in the ‘Report total’ tab of the M&V template and sum the total to provide the total kW saving achieved by your project. Your payment will be based on this total savings figure.

Example 1

Consider the Air Handling Unit replacement example from Case Study 2 in section 2.7.2 Full Measurement: Submetering. The project involved the replacement of the existing system with a more efficient alternative. The baseline was calculated and adjusted for seasonal variations using heating degree days.

Once the HVAC system has been installed, a savings report can be prepared once data for November 2015 – February 2016 is available from the submetering used to calculate the baseline data.

For this case, because there is seasonal variation, a WCSR can only be prepared and submitted once data for the winter peak is available, and the avoided demand reported is that for the months November 2015 – February 2016.

Example 2

Consider the multi-technology example from Case Study 1 in 2.7.4 Full Measurement: Total Building Electricity. The project was a multi-technology building retrofit where the baseline was calculated from average kWh consumption as there was no significant seasonal variation.

Once all of the measures have been installed, a savings report can be prepared once sufficient time has elapsed to provide a credible reporting period. This should be at least the same period of time as that used to calculate the baseline demand value.

The time of year used for the reporting period does not have to coincide with winter peak months because there is no seasonal variation in this case. Therefore, the savings reported will still be representative of those experienced over the winter peak.

M&V Plan and Calculation Template Completion Steps

You will need to return to your Boundary Spreadsheets with your Baseline calculations and complete the reporting tab for each.

You will have used one or more of the following three spreadsheets to calculate your baseline(s):

- Template Calculation for Partial Measurement
- Template Calculation for Full Measurement – Average Readings
- Template Calculation for Full Measurement – Regression Analysis

Each has a "Reporting" sheet that should be populated with post implementation data. Each template will calculate the kW saving once the information has been entered as follows:

For Partial Measurement:

- Record the date of readings in column A
- Record demand readings in kW in column B
- Record the peak applicability in the table at E33

For Full Measurement – Average Readings:

- Enter your meter data in the Data R tab to cover the entire reporting period.
- Record the dates of readings in columns A and B
- Record peak energy readings in column C

For Full Measurement – Regression Analysis:

- Enter your meter data in the Data R tab to cover the entire reporting period.
- Record the dates of readings in columns A and B
- Record peak energy readings in column C
- Record variable data in column D.

You should save each of your template calculation spreadsheets using the following naming convention:

Application ID, record category, description of file, ddmmyy

e.g. **GHTT0708-876 reporting B1 030515**

The total of your "Report" sheets should be summed in order to provide the overall demand savings of the project in the "Report Total" sheet of your M&V Plan. You should reference the Boundary Spreadsheet Name (e.g. B1) under column A and each kW value under column B.

FOR DEEMED SAVINGS REQUIREMENTS FOR REPORTING YOUR ACTUAL TIME OF USE SEE APPENDIX B.

End of Section Checklist

In following the process described for each approach above, the Winter Capacity Savings Reports should contain the following:

- A confirmation of the actual time of use over the winter peak period in the 'Winter peak use' tab of the M&V template.
- The energy or demand readings taken during the reporting period, including the dates if the readings
- The independent variables where these have been used (where relevant)
- Details of any corrections that have been applied to the data (e.g. to take account of changes in time of use)
- Details of any changes that have been applied to the baseline data, along with justifications for these changes
- The calculated demand reduction, following the method proposed in the M&V Plan

To note that details regarding the information you have to supply for the final report will be provided in due course.

4. Appendices and spreadsheet files

4.1. Appended documents:

Appendix A: Evidence Summary

Appendix B: Deemed Savings Manual

Appendix C: Operational Verification Example

Appendix D: Frequently Asked Questions

Appendix E: Key Decision Questions for Choosing your M&V Approach

Appendix F: Checking the Accuracy of your Baseline

Appendix G: Sampling Approaches

Appendix H: Deemed Measure Overviews and Data Calculations

4.2. Spreadsheet files

Templates

1. M&V Plan Template
2. Template Calculation for Partial Measurement
3. Template Calculation for Full Measurement – Average Readings
4. Template Calculation for Full Measurement – Regression Analysis
5. Sample Size Calculator

Deemed Spreadsheet Calculators

6. Heating Controls Calculator
7. Lighting Controls Calculator
8. Lighting Replacement Calculator
9. Motors and VSD Calculator
10. Process Chillers Calculator
11. PRSCs Calculator
12. RDCs Calculator

Examples (will be published when available)

13. Example M&V Plan for:
    a. Partial Measurement Approach
    b. Full Measurement: Submetering
    c. Full Measurement: Total Building
    d. Combined Approach (Total Building Electricity & Submetering)
14. Worked Example for Regression Analysis – Baseline
15. Worked Example for Regression Analysis – Reporting
16. Worked Example for Average kW Readings – Baseline
17. Worked Example for Average kW Readings – Reporting

Department of Energy & Climate Change
3 Whitehall Place
London SW1A 2AW
www.gov.uk/decc
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