مكتب التنظيم و الرقابة
Regulation & Supervision Bureau

Abu Dhabi Measurement and Verification Protocol 2017

Guidance Document

Guide

26 December 2017 EP/P04/102

Abu Dhabi Measurement & Verification Protocol 2017

Guidance Document

Issued by
the Regulation and Supervision Bureau
for the water, wastewater and electricity sector in the Emirate of Abu Dhabi
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Foreword

The Regulation & Supervision Bureau (the Bureau) has the duty under Law No (2) of 1998 to ensure, inter alia, the operation and development of a safe, efficient and economic water, wastewater and electricity sectors in the Emirate. Our responsibilities include promoting the conservation of water and electricity and maintaining the sustainability of these resources.

Accurate M&V is crucial to calculate and report Verified Savings resulting from implementation of Energy (and Water) Conservation Measures (ECMs). This document provides guidance on performing Measurement and Verification (M&V) for Energy Performance Contracting (EPC) projects performed by Energy Service Companies (ESCOs). It provides Landlords and ESCOs with a proper framework to ensure the accurate measurement and verification of energy saving projects.

This guidance document comes in support to the Government of Abu Dhabi drive for promoting energy efficiency.

This guidance document is also available for download from the Bureau's website at www.rsb.gov.ae.

SAIF SAEED AL QUBAISI

Director General

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Contents

1. Definitions

Words which are defined under this section are used in the document beginning with capital letters.

Where ECM is mentioned in the document it means the Energy and Water Conservation Measure, unless otherwise specified.

Terms in common use are not defined here and normal dictionary definitions apply.

Term	Definition
Adjustments, Non-routine & Routine	Changes made to the baseline and/or the performance period energy use to account for changes. Routine Adjustments are used to account for expected variations in independent variables; Non-routine Adjustments are used to compensate for unexpected changes unrelated to the energy conservation measures (ECMs).
Annual Report	A report issued annually, typically on the anniversary of project acceptance, which documents the execution and results of the M&V activities prescribed in the M&V plan. In an EPC, the energy savings documented in the report serves as the basis for the ESCO's invoice after the regular interval report has been reviewed and approved by the customer.
Avoided Energy Use	The reductions in energy use that occurred during the performance period relative to what would have been used during the baseline period, using actual operating conditions experienced during that period. This may require baseline energy use to be adjusted to actual conditions.
Baseline Conditions	Physical conditions that existed before implementation of the energy savings measures (such as equipment inventory and conditions, occupancy, nameplate data, energy consumption rate, and control strategies).
Baseline Energy or Demand	The calculated or measured energy use or demand by a piece of equipment or a site before implementation of the project.
Commissioning	The process of documenting and verifying through adjusting/remedying the performance of building facility systems so that they operate in conformity with the design intent. The American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Guideline 0-2013, *The Commissioning Process*, can be the basis for commissioning activities.
Energy Conservation Measure or Water Conservation Measure (ECM)	A measure that results in the reduction of energy or water use. A Energy Conservation Measure should satisfy the following requirements: (1) improve energy efficiency; (2) be life cycle cost- effective; and (3) involve energy conservation, cogeneration facilities, renewable energy sources, improvements in operation and maintenance efficiencies, or retrofit activities. A Water Conservation Measure should satisfy the following requirements: (1) improve the efficiency of water use; (2) be life cycle cost-effective; and (3) involve water conservation, water recycling or reuse, more efficient treatment of wastewater or storm water, improvements in operation or maintenance efficiencies, retrofit activities, or other related activities.
Energy Performance	A form of creative financing for capital improvement which allows funding energy (and/or water) upgrades from cost reductions. Under an EPC arrangement, an external organization

Contract (EPC)	(Energy Service Company - ESCO) implements a project to deliver energy (and/or water) efficiency and uses the stream of income from the cost savings to repay the costs of the project (including the costs of the investment). The ESCO will not receive its payment unless the project delivers energy (and/or water) savings as expected.
Energy Services Company (ESCO)	An organization that designs, finances, procures, installs, and possibly maintains one or more ECMs or systems at a facility or facilities, typically under an Energy Performance Contract.
Expected Savings	Expected savings are those reported in the post-installation report. They are based on as-built conditions and post-installation verification activities, and are the savings expected for year 1 of the project.
Independent Variable	A parameter that is expected to change regularly and have a measurable effect on the energy use of a building or system.
Interactive Effects	Energy consumption changes to one system resulting from changes made to another building system.
Measurement and Verification (M&V)	An evaluation procedure for determining energy (and/or water) savings and resulting cost savings.
M&V Option	One of four generic M&V approaches (A, B, C, and D) defined for EPC/ESCO projects. These options are defined in the IPMVP and in Section 3 of this document.
M&V Plan	The M&V plan is a document that defines project-specific M&V methods and techniques that will be used to determine savings resulting from a specific energy conservation project.
Measurements, Continuous	Measurements repeated at regular intervals over the baseline period or post-installation period.
Measurements, Short-term	Measurements taken for several hours, weeks, or months.
Operational Verification	Confirmation, through measurement and observation of performance that installed equipment has the potential to deliver the guaranteed or assured savings.
Performance Period	In an EPC, the time period spanning from acceptance of ECMs to the end of the contract term or a specific time frame, such as 1 year, within that period.
Performance Period Energy Use or Demand	The calculated energy use (or demand) by a piece of equipment or a site after implementation of the project.
Post-Installation Conditions	The physical and operational conditions present during the time period following the installation of an energy conservation project.
Post-Installation Report	The report that provides results of post-installation M&V activities, documents any changes in the project scope that may have occurred during project implementation, and provides energy savings estimates for the first year of performance.
Project-Specific M&V Plan	Plan providing details on how a specific project's savings will be measured and verified based on the general M&V options described in this document.

Regression Analysis	A technique used to develop a mathematical model from a set of data that describes the correlation of measured variables.
Static factors	Static factors include equipment and operating modes considered fixed during the M&V plan preparation. Thus, if a change occurs in the data and parameters, the baseline must be adjusted (permanently or temporarily).
Verified Savings	Savings reported in the annual report for the project based on verification activities conducted during the performance period and calculated for that specific year of the project.

2. Introduction

Scope and purpose

2.1 Accurate M&V is crucial to calculate and report Verified Savings resulting from implementation of Energy (and Water) Conservation Measures (ECMs).

2.2 This document provides guidance to performing Measurement and Verification (M&V) for Energy Performance Contracting (EPC) projects performed by Energy Service Companies (ESCOs).

2.3 Concepts and principle of M&V can be applied to both energy and water conservation. Hence, reference to energy and water conservation within the context of this guidance document is used interchangeably across the document.

Relevant documents

2.4 This document is based on best practice in M&V. The guidance provided here is heavily based on the following references:

(a) The International Performance Measurement and Verification Protocol, Energy Valuation Organization (EVO), IPMVP Core Concepts EVO 10000-1:2016.

(b) M&V Guidelines: Measurement and Verification for Performance-Based Contracts Version 4.0, the Federal Energy Management Program (FEMP), U.S. Department of Energy, November 2015.

(c) Industry best practice in M&V.

3. Overview of Measurement and Verification

Overview

3.1 Measurement and Verification (M&V) is the process of planning, measuring, collecting and analyzing data for the purpose of verifying and reporting energy savings within an individual facility resulting from the implementation of Energy Conservation Measures (ECMs). The same definition and principles apply to water savings and Water Conservation Measures.

3.2 Savings cannot be directly measured, since they represent the absence of energy use. Instead, savings are determined by comparing measured use before and after implementation of ECMs, making appropriate Adjustments for changes in conditions.

3.3 M&V is very important since it:

(a) provides accurate feedback over time to ensure savings are sustained, and highlights opportunities for improvement,

(b) aids facility managers in ensuring efficient maintenance and operations,

(c) documents the financial aspects of energy conservation improvements,

(d) provides the ability to weigh and reduce risk of Energy Performance Contracts (EPC), and

(e) is required when reporting energy savings for regulatory compliance, or to participate in emissions trading.

Challenges

3.4 The following challenges are typically encountered during M&V activities, which include:

(a) measuring Avoided Energy Use (against a "what could have been" energy baseline),

(b) implementing proper Adjustments for factors, such as weather, production volume, level of occupancy, etc. within and beyond control,

(c) accounting for Interactive Effects (for instance, when implementation of an ECM that will have an influence on the energy consumption of other equipment,

(d) remaining consistent with existing standards, other projects and in time,

(e) ensuring proper trade-off between rigor (accuracy & confidence) and effort,

(f) balancing interests of all involved parties, and

(g) aligning with local market specificities.

Fundamental principles

3.5 Good M&V practice is based on six fundamental principles as described below, in alphabetical order:

(a) **Accurate**: M&V reports should be as accurate as the M&V budget will allow. In addition, M&V costs should normally be small relative to the monetary value of the savings being evaluated. M&V expenditures should also be consistent with the financial implications of over/under reporting of a project's performance. Accuracy tradeoffs should be accompanied by increased conservativeness in any estimates and judgements.

(b) **Complete**: The reporting of energy savings should consider all effects of a project. M&V activities should use measurements to quantify the significant effects, while estimating all others.

(c) **Conservative**: M&V procedures should be designed to under-estimate savings where judgements are made about uncertain quantities.

(d) **Consistent**: Recognizing that any empirically derived report involves judgements which may not be made identically by all reporters, the reporting of a project's energy effectiveness should be consistent between:

(i) different types of energy efficiency projects,

(ii) different energy management professionals for any one project,

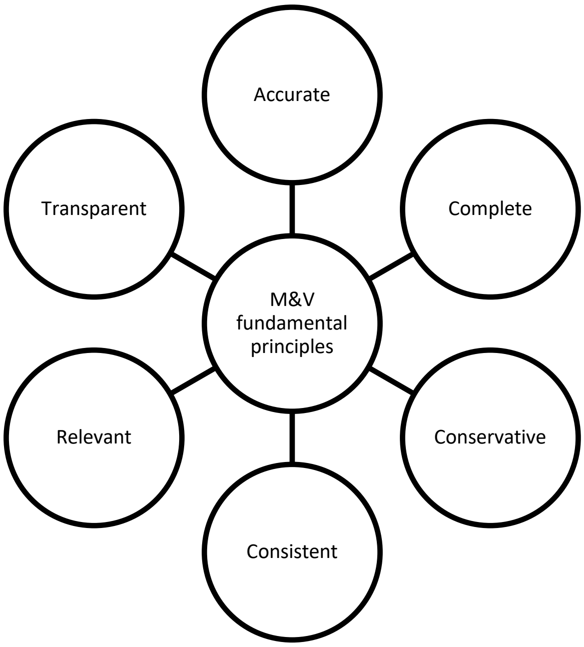
(iii) different periods of time for the same project, and

(iv) energy efficiency projects and new energy supply projects.

(e) **Relevant**: The determination of savings should measure the performance parameters of concern, or least well known, while other less critical or predictable parameters may be estimated.

(f) **Transparent**: All M&V activities should be clearly and fully disclosed.

Figure 3.1 M&V fundamental principles



International Performance Measurement and Verification Protocol

3.6 The International Performance Measurement and Verification Protocol (IPMVP) provides guidance for measuring the savings produced by energy efficiency initiatives or projects.

3.7 IPMVP is a compilation of best industry practices for determining the degree to which efficiency measures produce savings.

3.8 IPMVP provides a framework which determines energy and water savings resulting from the implementation of an energy efficiency program.

3.9 ECMs covered by IPMVP include:

(a) fuel saving measures,

(b) water efficiency measures,

(c) load shifting,

(d) energy reductions through installation or retrofit of equipment, and

(e) modification of operating procedures.

Savings Measurements

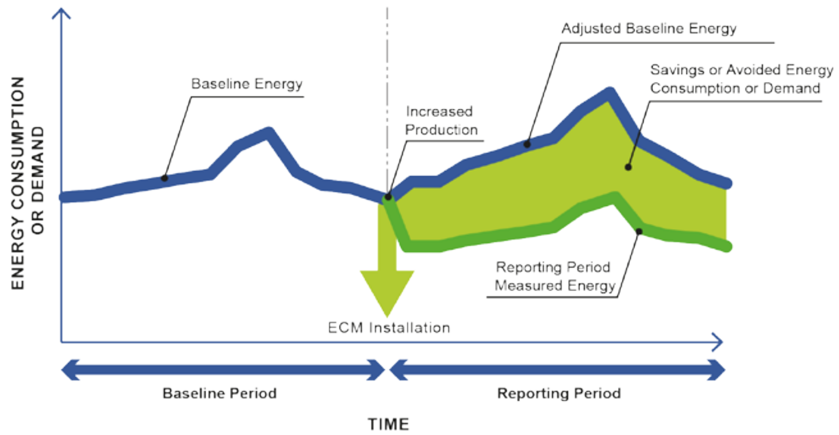
3.10 The very simple formula for measuring savings is defined below:

Energy Savings = Base Year Energy Use – Post Retrofit Energy Use + or – Adjustments

Where Adjustments are made in order to realistically compare post retrofit conditions to the base year conditions (i.e due to significant changes in square feet, weather differences and operational hours).

3.11 Illustration of saving measurements is shown in Figure 3.2

Figure 3.2: illustration of Saving Measurements



Source: Energy Valuation Organization (EVO)

Measuring Energy Consumption

3.12 There are two fundamental factors that drive energy savings, which are:

(a) Performance: which describes the amount of energy used to accomplish a specific task, and may also be referenced as efficiency or rate of energy use.

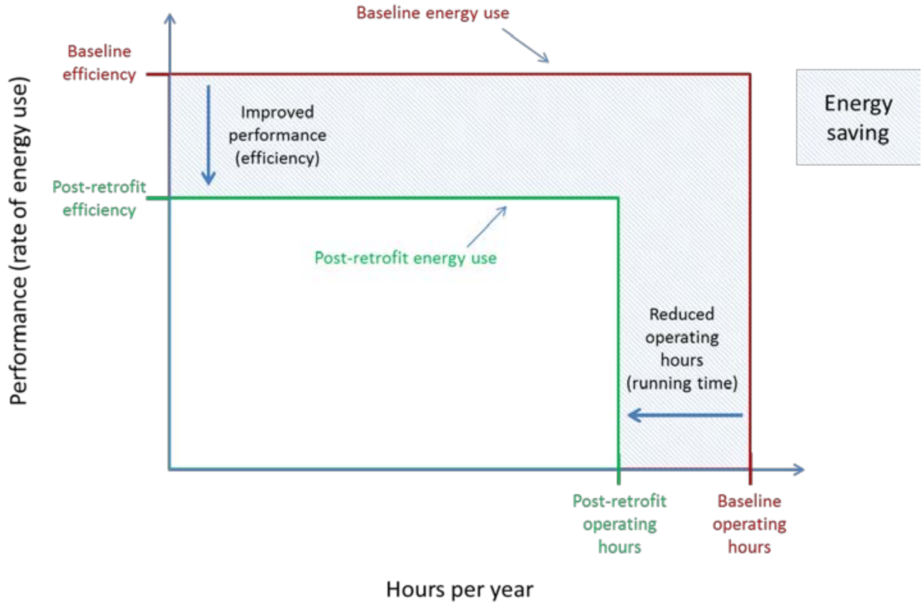
(b) Usage: which describes the operating hours, or total time, that a piece of equipment runs.

3.13 To determine saving, energy consumption must be calculated as follow:

Energy Consumption = Performance (Efficiency) X Usage (Operation Hours)

3.14 Figure 3.3 illustrates the impact of performance and usage improvements in achieving energy savings.

Figure 3.3 Impact of Energy Efficiency Measure



M&V Methods and Measurement Options

3.15 M&V approaches are divided into two general methods:

(a) Retrofit isolation methods: which look only at the affected equipment or system independent of the rest of the facility.

(b) Whole facility methods: which consider only the total energy use while ignoring specific equipment performance.

3.16 It should be noted that all savings are estimates since savings cannot be directly measured.

3.17 Generally, the accuracy of savings estimates improves as more measurements are used in defining the baseline and monitoring the Post-Installation Conditions.

3.18 Measurements are used to verify equipment operation and demonstrate that savings can be achieved.

3.19 Two measurements are made before and after installation, if the parameter is expected to change following installation.

3.20 Stipulating a parameter can be done and such case its value will be held constant regardless of what the actual value is and hence the measurement process for such parameter is eliminated.

3.21 IPMVP defines four options to measure savings that are termed "Options A, B, C, and D."

Option A - Retrofit Isolation with Key Parameter Measurement

3.22 Option A is a retrofit isolation approach, where actual generated savings must be verified from short-term data collection, and stipulated factors. It is a simple and low cost approach and is appropriate for less complex measures. Example: Lighting retrofit.

Option B - Retrofit Isolation with All Parameter

3.23 Option B is a retrofit isolation or system level approach, and requires continuous measurement to provide long-term verification of the savings. Option B methods are appropriate for complex systems whose operating conditions are highly dependent on external factors. Example: Variable-Speed Drive.

Option C - Whole-Facility Measurement

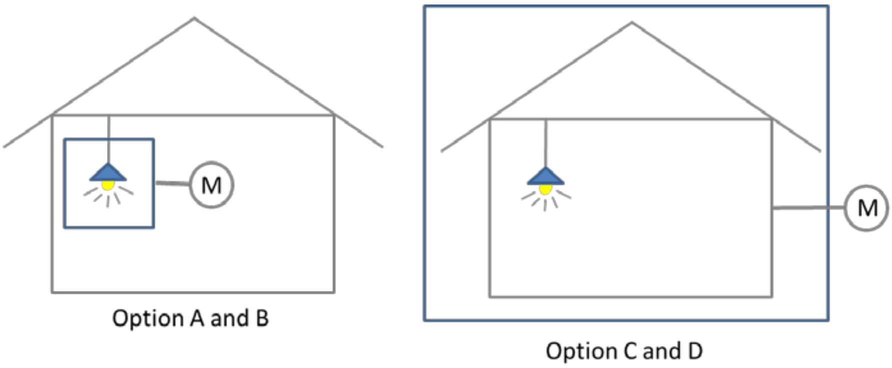
3.24 Option C is a whole-facility verification method. Savings are based on actual energy consumption as measured by the utility meter(s) and/or regression modelling. Option C methods are appropriate for projects whose measures have a high degree of interaction and when dedicated utility meters are available for retrofitted equipment or systems.

Option D - Calibrated Computer Simulation

3.25 Option D is primarily a whole-facility method but can be used at the component level. Option D uses calibrated computer simulation models of component or whole-building energy consumption. Option D methods are appropriate for complex projects. Example: New Building Construction.

3.26 Figure 3.4 provides an illustration of measurement boundary associated with the different M&V Options.

Figure 3.4 Illustration of Measurement Options: retrofit-isolation method (options A and B), whole-facility method (options C and D)



3.27 Annex A includes an Option selection diagram that provides guidance to select the appropriate option for M&V.

3.28 Table 3.1 summarizes M&V Options and provide examples for each.

Table 3.1 Summary of M&V Options

Measurement and Verification Options	Description	Examples
Option A - Retrofit Isolation with Key Parameter Measurement	This option is based on a combination of measured and estimated factors. Measurements are short-term, periodic, or continuous, and are taken at the component or system level for both the baseline and the retrofit equipment. Measurements should include the key performance parameters that define the energy use of the energy conservation measure. Estimated factors are supported by historical or manufacturers' data. Savings are determined by means of engineering calculations of baseline and reporting period energy use based on measured and estimated values.	Lighting retrofit projects. The key parameters are the power draws of the baseline and retrofit light fixtures. The operating hours are estimated based on facility use and occupant behavior. Energy savings are calculated as the difference in power draw multiplied by the operating hours.
Option B - Retrofit Isolation with All Parameter Measurement	This option is based on short-term, periodic, or continuous measurements of baseline and post-retrofit energy use taken at the component or system level. Savings are determined from analysis of baseline and reporting-period energy use.	Installation of a variable-speed drive and associated controls on an electric motor. Electric power is measured with a meter installed on the electrical supply to the motor. Power is measured during the baseline period to verify constant loading. The meter remains in place throughout the post-retrofit period to measure energy use. Energy savings are calculated as the pre-retrofit energy use (adjusted to correspond to the length of the reporting period) minus the measured energy use during the reporting period.

Option C - Whole-Facility Measurement	This option is based on continuous measurement of energy use (such as utility billing data) at the whole facility or sub-facility level during the baseline and post-retrofit periods. Savings are determined from analysis of baseline and reporting-period energy data. Regression Analysis is conducted to correlate energy use with independent variables such as weather and occupancy. Because this option requires a detailed inventory of all equipment included in the meter reading (as well as knowledge of equipment use patterns, building occupancy, and other factors affecting energy use), it is rarely used in projects. It can be appropriate for short periods or where equipment included in the meter reading is limited or can be controlled.	Replacement of a gas boiler. Using billed natural gas use data for 12 months during the baseline period, a baseline regression model is developed of monthly natural gas use with monthly heating degree days. Given the monthly heating degree days in a typical year at the site, the baseline model is used to determine baseline gas use in a typical year. Annually during the post-retrofit period a similar regression model is developed using billed natural gas and heating degree day data from the previous 12-month period. The reporting-period model is normalized to determine natural gas use in a typical year. Savings are defined as the normalized baseline gas use minus the normalized reporting-period gas use.
Option D - Calibrated Computer Simulation	Computer simulation software is used to model energy performance of a whole facility (or sub-facility). Models must be calibrated with actual hourly or monthly billing data from the facility.	Calibrated Computer Simulation

Source: IPMVP, Energy Valuation Organization (EVO)

4. M&V Process

M&V Plan

4.1 An M&V Plan is central to proper savings determination and the basis for verification.

4.2 It fundamentally defines how savings will be calculated, and should include the following elements:

(a) a description of the ECM and its intended result,

(b) an overview of the intended IPMVP option,

(c) documentation of post ECM and operating data,

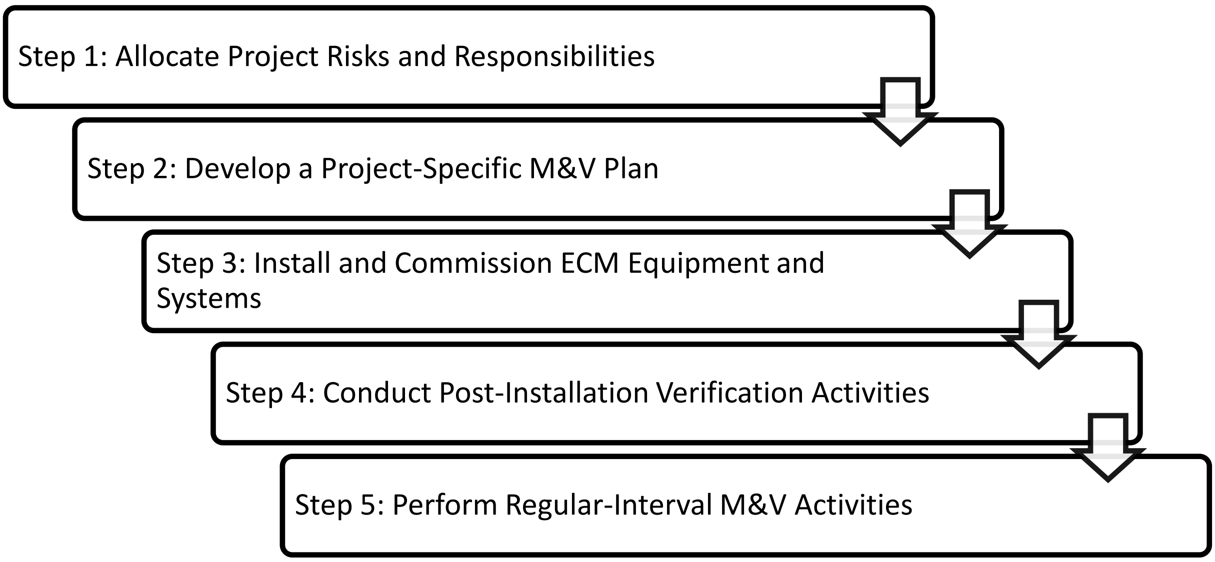
(d) savings report, and

(e) costs of M&V operations and equipment.

Steps to determine and verify savings

4.3 Figure 4.1 illustrate five steps to determine and verify savings.

Figure 4.1 Illustration of the steps to determine and verify savings



4.4 Step 1: Allocate Project Risks and Responsibilities

(a) The basis of any Project-Specific M&V Plan is determined by the allocation of key project risks and responsibilities between the ESCO and the customer involved.

(b) A number of typical financial, operational and performance issues must be considered when allocating risks and responsibilities.

(c) One of the primary purposes of M&V is to reduce risk to an acceptable level.

(d) Risk in the M&V context refers to the uncertainty that expected savings will be realized.

(e) Risk or uncertainty stems from:

(i) Usage Risk (i.e. how many hours equipment is used).

(ii) Performance Risk (i.e. equipment is not operating as intended).

(iii) Stipulation of the parameters Risk (i.e. over/under estimate of some parameters).

(f) The distribution of responsibilities will depend on the customer's resources and preferences, and the ESCO's ability to control certain factors.

(g) Annex B provides guidance to developing an M&V risk and responsibility matrix.

4.5 Step 2: Develop a Project-Specific M&V Plan

(a) In general the project specific M&V plan is developed during EPC contract negotiations.

(b) The M&V plan is the single most important item in an energy and water savings guarantee.

(c) The project M&V plan includes:

(i) Details of Baseline Conditions and data collected.

(ii) What will be verified, and who will conduct the M&V activities.

(iii) How energy and cost savings will be calculated.

(iv) How and why the baseline may be adjusted.

(d) Annex C provides further guidance on the contents and outline of the M&V plan.

4.6 Step 3: Install and Commission ECM Equipment and Systems

(a) Commissioning of installed equipment and systems is considered industry best practice.

(b) Commissioning ensures that systems are designed, installed, functionally tested in all modes of operation, and capable of being operated and maintained in conformity with the design intent (appropriate lighting levels, cooling capacity, comfortable temperatures, etc.).

(c) Commissioning usually requires performance measurements to ensure that systems are working properly.

(d) Because of the overlap in commissioning and post-installation M&V activities, the two activities are sometimes confused. The difference is that commissioning ensures that systems are installed per design criteria and functioning properly, whereas post-installation M&V quantifies how well the systems are working from an energy standpoint in support of the cost savings projections put forth by the ESCO.

4.7 Step 4: Conduct Post-Installation Verification Activities

(a) Post-installation verification is conducted by both the ESCO to ensure that proper equipment/systems were installed, are operating correctly, and have the potential to generate the predicted savings.

(b) After system start-up and commissioning activities are completed, the M&V acceptance testing activities are implemented.

(c) The results of the commissioning and M&V activities are usually presented in reports delivered prior to final project acceptance.

(d) The Post-Installation Report includes:

(i) Project description.

(ii) Installation verification – list of installed equipment.

(iii) Documentation of all post-install verification activities and performance measurements conducted.

(iv) Performance verification – how performance criteria were met.

(v) Expected savings for the first year.

4.8 Step 5: Perform Regular-Interval M&V Activities

(a) M&V must be performed at regular intervals to ensure that the installed equipment is operational and is delivering the savings that were proposed. In EPC projects, typically M&V is required to be performed on an annual basis.

(b) Operational Verification is an important part of the periodic M&V process. With proper coordination and planning, M&V activities that provide Operational Verification of an ECM (i.e., confirmation that the ECM is operating as intended) during the Performance Period can also support ongoing commissioning activities (e.g., recommissioning, retro-commissioning, or monitoring-based commissioning).

(c) Most forms of M&V require some periodic measurement of operational performance (or at a minimum, equipment inspection or trending of operational logs).

(d) In EPC projects, an annual report (unless otherwise specified in the EPC contract – i.e. reports on quarterly basis) often is required to document annual M&V activities and report verified and guaranteed savings for the year. In many cases, however, more frequent verification activities are appropriate. More frequent monitoring and/or inspection ensures that the M&V monitoring and reporting systems are working properly and that installed equipment and systems are operating as intended throughout the year, allows fine-tuning of measures throughout the year based on operational feedback, and avoids surprises at the end of the year.

(e) M&V Reports in EPC projects typically must include the following.

(i) Results/documentation of performance measurements and inspections.

(ii) Verified Savings for the year (energy, energy costs, O&M costs, etc.).

(iii) Comparison of Verified Savings with the guaranteed amounts.

(iv) Details of all analysis and savings calculations, including rates used and any baseline Adjustments performed.

(v) Summary of operations and maintenance activities conducted.

(vi) Details of any performance or O&M issues that require attention.

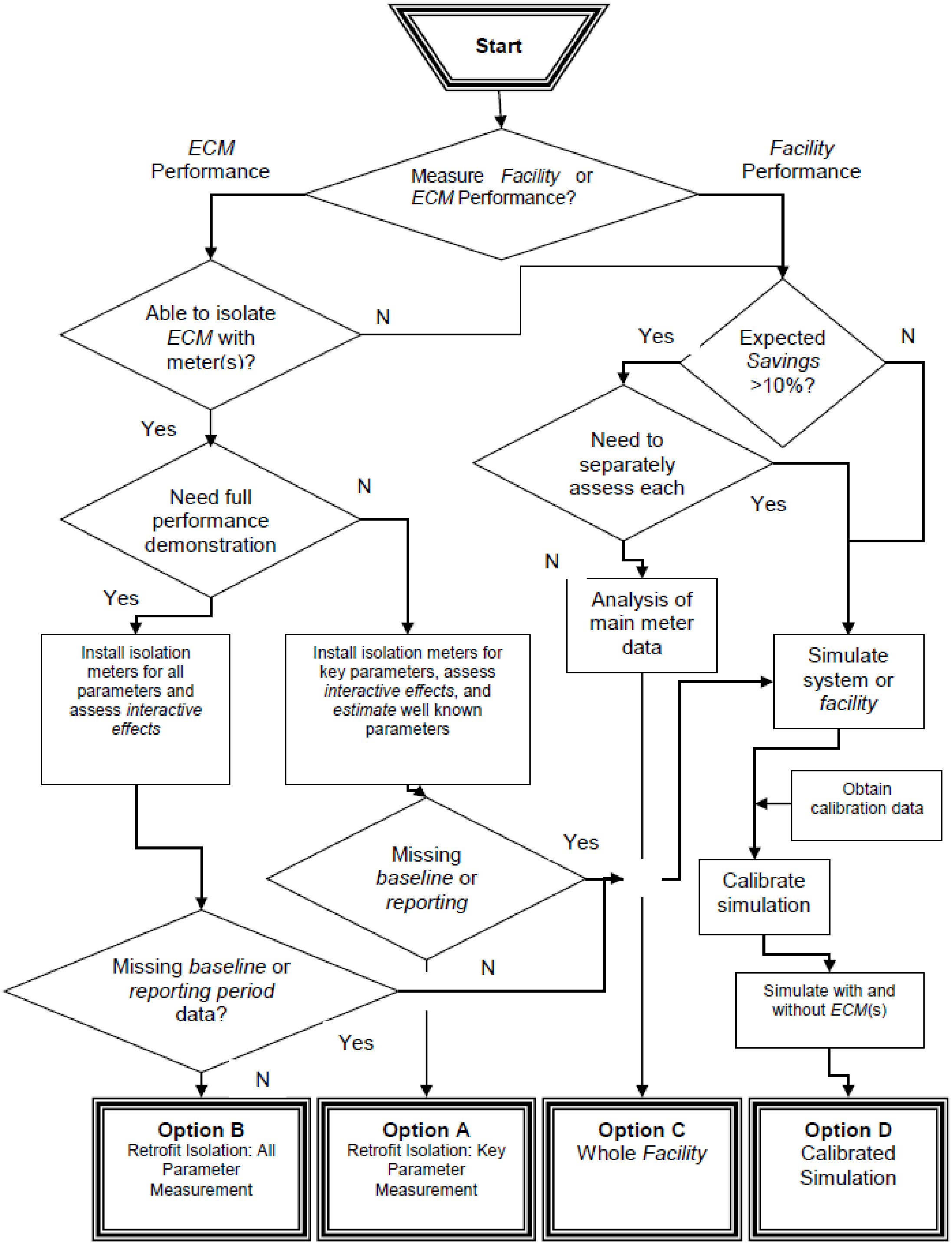
Third Party Verification

4.9 According to the IPMVP, “where the firm performing the energy savings determination has more experience than the owner, the owner may seek assistance in reviewing savings reports.”

Annex A: Option selection process diagram

A.1 Figure A.1 includes an Option selection diagram that provides guidance to select the appropriate option for M&V.

Figure A.1 Option selection process diagram



Source: Energy Valuation Organization (EVO)

Annex B: Risk and responsibility matrix

B.1 Table B.1 provides a template that provides guidance to developing an M&V risk and responsibility matrix.

Table B.1 Risk and responsibility matrix

Responsibility	**ESCO/Contractor-Proposed Approach**
1. Financial	
a. Interest rates	
b. Energy Prices	
c. Construction costs	
d. Measurement and verification (M&V) confidence	
e. Energy-Related Cost Savings	
f. Delays	
g. Major changes in facility	
2. Operational	
a. Operating hours	
b. Load	
c. Weather	
d. User participation	
3. Performance	
a. Equipment performance	
b. Operations	
c. Preventive Maintenance	
d. Equipment Repair and Replacement	

Annex C: Outline of M&V Plan

C.1 This section provides guidance on the outline and content of M&V plan.

C.2 The purpose of this guidance is to ensure the various elements of an M&V plan is captured.

C.3 M&V plan may be developed by the ESCO and may be reviewed by a qualified third party such as a Certified Measurement and Verification Professional (CMVP) by the Association of Energy Engineers (AEE).

C.4 The M&V plan should cover the following sections:

1. Description of program / target facilities
2. Conservation measures (Electricity/Water)
3. Measurement option and boundary
4. Baseline period, electricity/water and conditions
    a. Identification of the Baseline Period
    b. Baseline Electricity/water Consumption and Demand
    c. Independent Variables
    d. Static Factors
5. Reporting period
6. Basis for adjustment
7. Descript of baseline adjustment methodology
    a. Routine Adjustments
    b. Non-routine Adjustments
8. Electricity/water price adjustment (if any)
9. Meter specifications
10. Monitoring responsibilities
11. Expected accuracy
12. Report responsibilities
13. Budget
14. Format of M&V reports
15. Quality assurance
16. Appendices

C.5 The following section provides guidance template for preparing an M&V plan, and outline of the M&V report.

1. Description of program / target facilities
2. Conservation measures (Electricity/Water)

Table C.1 Conservation measures (Electricity/Water)

Measures List	**Expected Result**	**Energy/Water Conservation Measure (ECM) Description**
Measure 1:		
Measure 2:		
Measure 3:		

[The analyst must also present the commissioning procedures that will be used to verify the implementation of each ECM. Identify any planned changes to conditions of the baseline, such as unoccupied building temperature settings.]

3. Selected IPMVP Option and Measurement Boundary

IPMVP Option Used to Determine Savings
Option X According to IPMVP Core Concepts EVO 10000-1:2016

Justification of the Selected Option, Gain/Reporting Period Ratio

Measurement Boundary

4. Baseline period, electricity/water and conditions
   a. Identification of the Baseline Period

      The baseline period starts on [date] and ends on [date]. This period covers electricity and water consumption. [The analyst must explain the reasons for selecting this period.]

   b. Baseline Electricity/water Consumption and Demand

      Baseline electricity consumption and demand data come

Table C.2 Baseline Electricity/water Consumption and Demand

Period		Consumption/Demand
From	**To**	**Electricity (kWh/kW) or Water (cm/IG)**
xx	**xx**	
xx	**xx**	
…	**...**	
xx	**xx**	
TOTAL		

c. Independent Variables

Independent variables include factors that can affect facility energy consumption or demand and that will be included in a systematic way to determine the periodic adjustment of the baseline during the reporting period.

In this case, cooling degree-days data from the National Metrological Center (source: http://www.ncm.ae) will need to be used.

Table C.3 Cooling degree days

Period		Cooling degree days
From	**To**	**°C**
xx	**xx**	
xx	**xx**	
…	**...**	
xx	**xx**	
TOTAL		

d. Static Factors

Static factors include equipment and operating modes considered fixed during the M&V plan preparation. Thus, if a change occurs in the data and parameters, the baseline must be adjusted (permanently or temporarily).

The list below identifies a series of potential static factors as examples. This list is not representative any other factor likely to influence energy needs could be added.

Table C.4 Potential static factors

Potential static factors
• Number and capacity of production lines; • Utilization schedule; • Product types; • Temperature set points; • Building standards and legislation; • Manufacturing standards and legislation • Building utilization; • Building floor area; • Number and capacity of HVAC systems; • Ventilation operating hours; • Lighting utilization hours; • Amount of supply outdoor air; • Hot and chilled water temperature.

5. Reporting period

Table C.5 Reporting period

Reporting period
The reporting period starts on [date] and lasts [number] days/weeks/months from project planning to M&V plan preparation.

6. Basis for adjustment

Table C.6 Basis for adjustment

Retained Option	Equation
Avoided Energy Use (or savings)	Baseline energy (+/-) Routine Adjustments to reporting period conditions (+/-) Non-routine Adjustments to reporting period conditions (-) Reporting period energy
Avoided Demand	Baseline demand (+/-) Routine Adjustments to reporting period conditions (+/-) Non-routine Adjustments to reporting period conditions (-) Reporting period demand

In the equation above, the calculation of "baseline energy" and "Routine Adjustments" will be performed simultaneously through the baseline mathematical model. The same applies to the avoided demand calculation.

7. Description of baseline adjustment methodology

Table C.7 Baseline adjustment methodology

Routine Adjustments: (R)	**Y**	**N**	**Non-Routine Adjustments: (NR)**	**Y**	**N**

[The analyst must present the baseline mathematical model for each site. For illustrative purposes, we present a baseline model with two independent variables.]

Linear Regression Analysis is considered satisfactory according to generally accepted standards for this type of analysis. The following table presents statistical indicators for this regression that needs to be met.

Table C.8 Regression Analysis Statistics for Electricity

Statistical Test	**Value**	**IPMVP**
Coefficient of Determination		> 0.75
Coefficient of Variation of RMSE		< 0.05
t-statistic (X1)		< -2 or > 2
t-statistic (X2)		< -2 or > 2
t-statistic (baseline consumption)		< -2 or > 2
Comments		

Baseline adjustment in case of equipment addition/removal/shutdown or change in the operation

In the event that the facility adds/removes/stops equipment or changes its operation, data will be collected from plans and specifications, equipment specifications, manufacturer and contractor information and/or short-term measurement campaigns. The procedure will be based on the impact of such change on static factors. The new devices' operating hours may be estimated based on the type of use, at the customer's convenience.

Adjustments will be defined either as temporary (applicable to a portion of the reporting period) or permanent (remains in effect for the rest of the reporting period).

8. Electricity/water price adjustment (if any)

Specify the energy prices that will be used to value the savings (as defined in the RFP document),). Cost savings are determined by applying the appropriate price schedule in the following equation:

$$\textit{Cost Savings} = C_b - C_r$$

Where: C_b = Cost of the baseline energy plus any Adjustments, C_r = Cost of the reporting period energy plus any Adjustments

9. Meter specifications

[Specify the metering points and period(s) if metering is not continuous. For non-utility meters, specify meter characteristics, meter reading and witnessing protocol, meter commissioning procedure, routine calibration process and method of dealing with data collection errors and lost data

If the main meter measuring electricity/water consumption is utility name's meter, it is deemed to comply with the protocol requirements without any additional validation.

10. Monitoring responsibilities

Table C.9 Monitoring responsibilities

Person in Charge	**Recording the Energy Data**		**Independent Variables**		**Static Factors**	
	Data	**Frequency**	**Data**	**Frequency**	**Data**	**Frequency**
Organization						
Company Preparing the M&V Report						

11. Expected accuracy

[The analyst must present the calculation of expected accuracy based on sampling, metering precision, …etc.]

12. Report responsibilities

Table C.10 Report responsibilities

Person in Charge	
Frequency	
Transmission	XX days following the end of the first year of the reporting period

13. Budget

Table C.11 Budget

	Instrumentation	**Readings/Analysis/Report**
Baseline Period		
Reporting Period		
TOTAL		

14. Format of M&V reports

Table C.12 Format of M&V report

Format of M&V reports
Project name **Date** 1. Updated baseline a. Values of data input b. Values of the independent variables 2. Adjustment factors for the period a. Current b. Non-routine c. Routine 3. Readjusted reference year calculation

4. Energy savings calculations for the period
5. Evaluation of cumulative savings from the start of the project, on a yearly basis

15. Quality assurance

[Describe how quality assurance will be ensured.]

16. Appendices

[Include any referenced appendices.]