MONITORING AND VERIFICATION GUIDELINES

Click to begin

TOPICS

- **Objective of the module**
- **About Monitoring & Verification**
  - Introduction to M&V
  - Importance of M&V
  - Risks associated with M&V
  - Key activities under M&V
- **Monitoring & Verification options** (As per IPMVP protocol)
  - Retrofit Isolation with key parameter measurement
  - Retrofit Isolation with all parameter measurement
  - Whole Facility measurement
  - Calibrated computer simulation technique
  - Comparison between options
- **Selection of M&V approach**
  - ECM Lighting Illustration

OBJECTIVE OF THE MODULE

- The prime objective of this module is to develop the basic understanding of standard M&V guidelines, among energy managers, procurement officers, contractors and other concerned personnel.

- The key objectives are as follows:

Develop basic understanding of M & V

Highlight the need and importance of M&V

Introduction to technology specific M&V guidelines

INTRODUCTION TO M&V (1/3)

- Measurement and Verification is a process of quantifying the energy and subsequently the cost savings resulting from the energy efficiency measures implemented on any given energy-consuming system.
- This quantification of energy savings is done based on comparison of energy consumption post-implementation of energy efficiency measures against the historical baseline consumption with adjustment.
- M&V is very essential for a **Performance Based Contract.**
- Standard M&V guidelines exists for all energy efficiency measures.

Performance Based Contracts

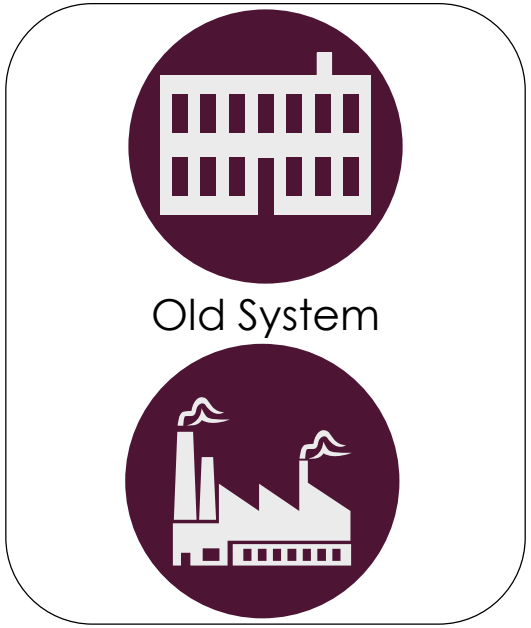
- ❑ Herein, a third party contractor (ESCO/utility company) ensures/ guarantees a particular level of performance of energy consuming equipment or some minimum energy savings based on identified energy conservation measures for a given energy consuming system.
- ❑ The contractor is responsible for supply, installation and commissioning (may include periodical maintenance) of EE measures.

INTRODUCTION TO M&V (2/3)

- General equation to calculate savings

$$Savings = (Baseline\ Energy\ - Post\ Installation\ Energy) \pm Adjustments$$

Energy Consumption = A = Baseline Energy



Energy Efficiency Measures

Energy Consumption = B = Post-Installation Energy

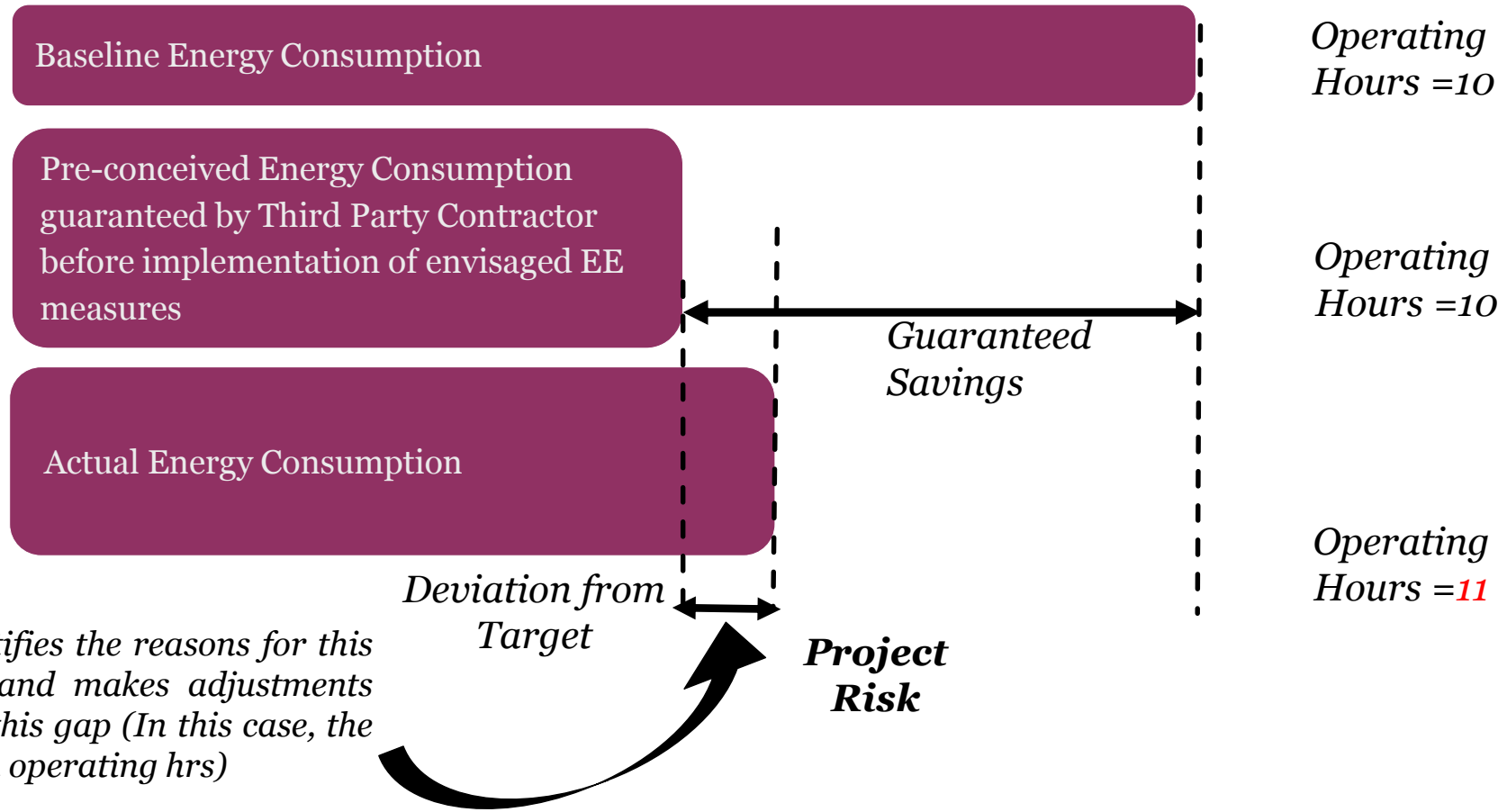
New and Improved System

Actual Savings = (A-B)

Then Why Adjustments?

INTRODUCTION TO M&V (3/3)

Illustration 1: Consider the Case where a third party has committed to reduce the lighting energy consumption of a building by 50% by installing new lights that are 50% more efficient than the currently installed lights.



M&V identifies the reasons for this deviation and makes adjustments to Bridge this gap (In this case, the increase in operating hrs)

IMPORTANCE OF M&V

- Aids in monitoring equipment performance
- Distributes risks (uncertainty that the expected savings will be realized) between contractor and customer, minimizing the chances of project failure.
- Accurately assesses the energy savings to ensure economic viability of the project as perceived before and highlights any impending risks.
- Improves O&M practice

RISKS ASSOCIATED WITH M&V

Reducing complexity of M&V plan is key to successful execution of any energy savings performance contract. Customers and contractor must agree to take responsibility for certain risks to ensure robustness of M&V plan.

Risks can be categorized into three types:

Financial Risks

- Interest rates
- Energy Prices
- Construction costs
- M&V Confidence
- Energy-Related cost savings
- Delays
- Major Changes in facility

- Example: Increase in Interest rate/ energy prices may lead to increased cost to customer, reducing the savings initially committed by contractor.

Operational Risks

- Operating hours
- Load
- Weather
- User Participation

- Example: Increased occupancy of a building may reduce the perceived energy savings due to increased cooling load causing more energy consumption.

Performance Risks

- Equipment performance
- Operations
- Preventive Maintenance
- Equipment repair and replacement

- Example: Deviation from the expected performance of new equipment may lead to reduced savings or bad maintenance practices may increase consumption

Minimization of above risks reduces the complexity of any M&V plan

KEY ACTIVITIES UNDER M&V

The key activities in any M&V plan are:

Pre-installation Phase

Key Activities:

- Deciding the measurement and verification boundary
- Estimation of baseline energy consumption
- Recording/ documentation of factors considered for estimation of baseline energy
- Acknowlegement of perceived risks (financial/performance/operational)

Post-installation phase

Key Activities:

- Estimation of post installation energy consumption
- Recording/ documentation of factors considered for estimating energy consumption
- Comparison of these factors with those considered for estimation of baseline energy
- Adjustments to energy savings based on risk distribution between contractor and customer for any identidied deviation in operational/financial/ performance parameters.

MONITORING & VERIFICATION OPTIONS - AS PER IPMVP PROTOCOL (1/5)

1. Retrofit Isolation with Key Parameter Measurement
2. Retrofit Isolation with All Parameter Measurement
3. Whole-Facility Measurement
4. Calibrated Computer Simulation

RETROFIT ISOLATION WITH KEY PARAMETER MEASUREMENT (2/5)

- Involves equipment-level M&V assessment
- Uses a combination of estimated and measured values to determine energy savings
- Measurements can be short-term, periodic, or continuous for the baseline and retrofit equipment
- The estimated values are based on historical/ manufacturers data.
- Savings determined by means of engineering calculations.
- Used mainly for the end-use technologies

Illustration: Lighting retrofit projects

- ❑ Key parameter, i.e. power is measured for baseline and retrofit installations
- ❑ Operational parameter, i.e. no. of operating hours is estimated using occupancy variation/ facility use
- ❑ Savings = (Baseline – Retrofit)*(Estimated operating hours)

RETROFIT ISOLATION WITH ALL PARAMETER MEASUREMENT (3/5)

- Involves system-level M&V assessment
- Baseline and post-retrofit energy use is determined by short-term, periodic or continuous measurement of energy
- Savings is determined by means of analysis of baseline and post-retrofit energy use.
- Used mainly for the end-use technologies

Illustration: Installation of VFD on motor

- ❑ Key parameter, i.e. power is measured by meters on supply side of the motor. The meters remain installed during pre-retrofit and post-retrofit periods.
- ❑ Measurement of power during baseline period ensures constant loading.
- ❑ Energy use during baseline period, is adjusted for duration of post retrofit measurement and energy saving is estimated

WHOLE-FACILITY MEASUREMENT (4/5)

- Involves facility-level M&V assessment
- Generally, data sources such as utility bills are used to determine energy consumption during baseline and post-implementation periods.
- Additional information on all other energy-consuming equipment in the facility, their usage pattern and their dependence on independent factors such as weather, occupancy rate etc. is required to accurately quantify energy savings
- Suitable for facility with limited no. of equipment.

Illustration: Replacement of conventional air conditioning equipment with energy efficient new technology equipment in a building

- ❑ Difference in utility billing for baseline and post-implementation period does not determines energy saving
- ❑ Understanding of behaviour of all other energy-consuming equipment and variations in external factors is required.
- ❑ Adjustment in energy use pattern is required to normalize the utility bills for the two periods to actually quantify savings

CALIBRATED COMPUTER SIMULATION TECHNIQUE (5/5)

- Involves assessment based on computer simulation
- Requires modelling of energy performance of whole facility.
- Information on performance characteristics of existing and new equipment/system, facility characteristics, projected estimates, measured short-long term energy consumption data for system components etc. is required for proper calibration of the model.
- The model determines the energy savings for the baseline and post-installation period

Illustration: Implementation of multiple ECMs in a building

- ❑ Simulation model is developed with baseline equipment and calibrated for 12 months of utility bill
- ❑ Performance characteristics of new equipment is input into the model to determine post-installation energy use
- ❑ Difference in post-installation and baseline energy use determines the energy savings

COMPARISON BETWEEN M&V OPTIONS

Parameter	Retrofit Isolation with key Parameter Measurement	Retrofit Isolation with Parameter	Whole-Facility Measurement	Calibrated Computer Simulation
Assessment	Equipment level	System/Equipment Level	Facility level	Facility level
Preferred Usage	End use technologies	End use technologies	Multiple Interactive Conservation measures in large facility	Multiple Interactive Conservation measures in large facility
Complexity	Minimum	Medium	High	High
Effort and Cost	Minimum	Medium	High	High
Expertise required to carry out M&V	Medium	Medium	High	High

SELECTION OF M&V APPROACH

Project Costs and Projected Savings

- Value delivered by M&V must comply with ECM value and Project cost
- Generally M&V costs may range from 2-5% of annual project cost

Complexity of ECM or System

- Constant load, constant operating hours
- Constant load, variable operating hours
- Variable load, variable operating hours

Increasing Complexity of ECM demands complex M&V

Interrelated ECMs at a single facility

- It means a part of savings from one measure, resulting from another
- Such situations requires more complex M&V approach such as whole-facility measurement or calibrated computer simulation

Risk of achieving Savings

- Unproven technologies increases the risk of achieving targeted savings and hence calls for complex M&V plans.
- Greater familiarity with ECMs reduces the risk of failure

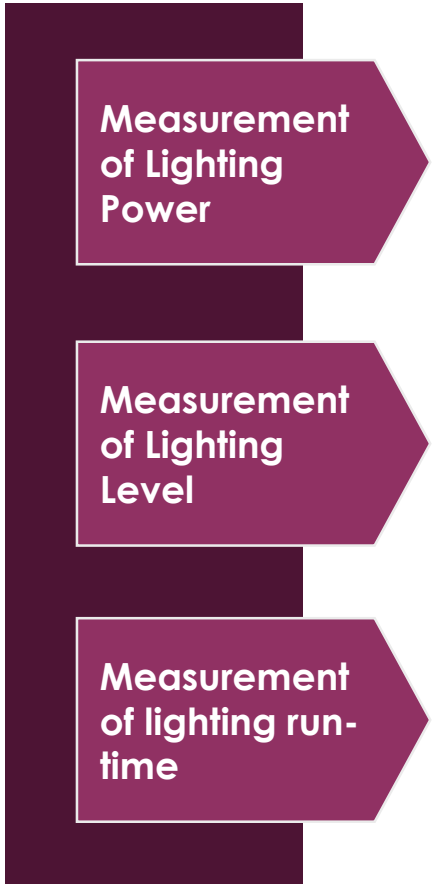
ECM LIGHTING ILLUSTRATION (1/2)

ECM: Lighting

- ECM Description: Implementation of LED lights in place of conventional fixtures
- Suggested M&V option : Retrofit Isolation with key Parameter Measurement

M&V Plan	Lighting Power (kW)		Lighting Levels (lumens)		Lighting Run Time (hours)	
Period	Sampling	Measurement Type	Sampling	Measurement Type	Sampling	Measurement Type
Baseline	10-20%	Spot	10-20%	Spot	10-20%	Short-term metering
Post -	10-20%	Spot	10-20%	Spot	Not required	Same as Baseline

ECM LIGHTING ILLUSTRATION (2/2)



- **It is recommended to measure lighting power consumption of 10-20% of the light points during baseline and post-installation phase using spot measurements**
- **All different type of lightings must be checked for power consumption**

- **Efficacy of lighting system is usually spot measured.**
- **About 20% samples should be checked for lighting levels during baseline and post-installation periods**

- **Short-term data logging should be used to verify the no. of operating hours of the lighting system.**
- **The data logging needs to done at sites representing at least 80% of the lighting energy use**

QUIZ TIME

Lets check what you have learnt till now.

Answer the questions correctly OR

Consider revising this module … All the Best !!

NOTE: Click on the suitable option for answering the question

Q 1. Monitoring and Verification has the following benefits listed below **except**

1. Aids in monitoring equipment performance
2. Increases the difficulty in Operation and Maintenance
3. Distributes risks (uncertainty that the expected savings will be realized) between contractor and customer, minimizing the chances of project failure
4. Accurately assesses the energy savings to ensure economic viability of the project

QUIZ TIME

Q 2. Effort and Cost implications **are minimum** for which of the following M & V technique?

1. Retrofit Isolation with all parameter measurement
2. Whole facility measurement
3. Calibrated Computer Simulation technique
4. Retrofit Isolation with key parameter measurement

QUIZ TIME

Q 3. When performing a Monitoring and Verification to calculate the actual energy / cost savings, it is important to take into account suitable ***ADJUSTMENTS*** because

1. Actual energy savings can be different from pre-conceived savings due to change in operating conditions
2. Baseline calculation can be incorrect
3. Performance contract is based on the actual savings made from implementing a ECM
4. Both 1 and 3

QUIZ TIME

Q 4. To ensure that there are minimum risks resulting from a Monitoring and Verification process, the Energy Performance Contract must ensure that the following aspect /aspects is / are included in it

1. Change in interest rates / energy prices
2. Change in weather conditions / load conditions thus altering the operations process
3. Faulty new equipment or bad maintenance practices by the unit
4. All of the above

End of Training Module

THANK YOU

Congratulations !!

That's a correct response…

Next question

Sorry !!

That's incorrect…

Try again

Next question

Congratulations !!

That's a correct response…

Next question

Sorry !!

That's incorrect…

Try again

Next question

Congratulations !!

That's a correct response…

Next question

Sorry !!

That's incorrect…

Try again

Next question

Congratulations !!

That's a correct response…

Exit

Sorry !!

That's incorrect…

Try again

Go to the beginning of the module

Exit