Module 12: Quality Assurance

Ensuring that audits comply with DME requirements

Learning Objectives

- Describe the essential features of the DME Audit Guidelines
- Summarize the prescribed process for preliminary and detailed audits
- Ensure that the preliminary and detailed audits address all required assessment issues
- Ensure that appropriate service providers for the audit and quality assurance are selected

Audit Process
Audit Process

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Parties to the Process

- Energy Supplier (utilities)
- Site Management
- ESCO
- Quality Assurer
- DME
- DPW

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Preliminary Audit

- **Purpose**
  - the need for or merits of a detailed audit, based on performance indices:
    - consumption index
    - demand index

- **Steps**
  - historical analysis
  - collect building data
  - demand profile
  - walk-through
  - tariff analysis
Preliminary Audit Findings

- Building performance indices
- Demand profile analysis
- Potential savings opportunities
- Confirmation of tariff

Detailed Audit

- Purpose
  - identify specific measures to reduce consumption, demand, cost
- Steps
  - examine site drawings
  - prepare load inventory
  - assess demand profile
  - assess all energy load areas
  - provide baseline criterion
  - assess tariff change opportunity

EMO Checklist

- Lighting
- HVAC
- Building envelope
- Domestic hot and cold water
- Steam distribution
- Fuel switching
- Compressed air
**Quality Assurance Issues**

- Ensure that the process is followed
- Select the right ESCO
- Select the right Quality Assurer

- Education of employees, in particular additional specific Energy Management related certification or degrees.
- Expertise and integrity of company.
- Reference projects and other experience.
- Stability of company (assets / turnover).
- Professional indemnity and contractor’s liability insurances.

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**Module 13: Project Development Cycle**

**Planning, Implementation and Evaluation**

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**Learning Objectives**

- Design and document a project
- Develop the necessary documentation for project approval
- Develop the necessary documentation for securing financing
- Select contract types and contractors
- Monitor project implementation
The steps in the PDC

- Project Definition and Scope
- Technical Design
- Financing
- Contracting
- Implementation and Monitoring

Step 1: Project Definition and Scope

- **Internal**
  - facility manager identifies a package of energy-savings opportunities during the day to day energy management activities, or from facility audits.

- **External**
  - systematic energy audits undertaken by a reputable energy management consultant, energy service company

Criteria for Prioritisation

- Cost-effectiveness
- Sustainability of the savings
- Ease of quantifying, monitoring, and verifying savings
- Availability of technology
- Other environmental and social costs and benefits
Step 2: Technical Design

- The proposed technologies, process modifications, equipment replacements and other measures
- Product/technology/material supply chain
- Commercial viability of the measures (IRR, NPV, cash flow, payback)
- Any special technical complexities
- Preliminary designs, manufacturer's name and contact details, and capital cost estimate
- Organisational and management plan for implementation

Step 3: Financial Proposal

- Amount of financing already secured
- Project cost structure
  - investment required at each stage
  - proposed investment structure (debt-equity)
  - risk mechanisms (insurance, currency exposure, guarantees, etc.)
- Use of proceeds from the loan
- Certification on due diligence and efficiency

Loan Agreements

- Conditions regarding goods and services procurement
- Inspection provisions
- Conditions regarding insurance
- Information requirements
- Termination provisions
**ESCO Services**

- An energy efficiency opportunity analysis
- Project development
- Engineering
- Financing
- Construction/implementation
- Training
- Measurement and verification

**Benefits of 3rd Party Financing**

- Reduced or eliminated need for corporate capital
- Accelerate existing energy efficiency programs and building renewal
- Helping manage debt through off balance sheet financing
- Decreased operating costs
- Turn-key installation
- Participation of local energy utilities
- Enhanced staff training
- Savings fund repayments, based on performance against quantifiable results
- Transferred risk to a third party (ESCO)

**Step 4: Contracting Options**

- Traditional contract
- Extended technical guarantee/service
- Extended financing terms
- Guaranteed savings performance contract
- Shared savings performance contract
**ESCO Contract Types**

- **First Out** - ESCO retains savings until an agreed-upon financial goal is achieved; client company then receives future savings
- **Shared Savings** - ESCO and client company share savings as they are achieved
- **Guaranteed Savings** - ESCO guarantees project costs (exclusive of client add-ons); debt service is covered by the income stream.
- **Discounted Energy Savings (Chauffage)** - Client company pays ESCO a fee equal to the base year energy bill minus an agreed-upon discount; ESCO pays actual energy bill

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**Step 5: Implementation Guidelines**

- Limit long lead times
- Manage out-of-pocket development costs by focusing efforts
- Manage construction carefully

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**Module 14: M&V**

**Savings Verification**

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Learning Objectives

- Identify the key concepts involved in savings verification
- Define the kinds of data required for energy performance analysis, and analyze energy consumption as a function of degree-days
- Define the fundamental relationship for determining savings for a given ECM
- Describe the elements of a verification plan
- Identify the data and information required to define base year conditions
- Describe and select from the four methods of savings verification
- Describe techniques for developing an energy performance model
- Apply adjustments to the base year conditions

Working Definitions

- **Measurement and Verification**: a process of quantifying energy consumption before and after an ECM is implemented to verify and report on the savings actually achieved
- **Monitoring and Targeting**: a management technique to “keep operations efficient”, and to “monitor utility costs”-management strategies to drive energy costs downwards as a continuous improvement cycle

Why Measure & Verify?

- to increase energy savings
- to reduce the cost of financing projects
- to encourage better project engineering
- to demonstrate and capture the value of reduced GHG emissions
- to increase public understanding of energy management as a public policy tool
- to promote and achieve resource efficiency and environmental objectives
Spend more to reduce costs?

M & V
- Increases the confidence of funders in sufficient savings to make debt payments
- Reduces the investment risk
- Reduces the expected rate of return of the investment—and your costs of borrowing

Determining Savings

Savings = Adjusted Baseline Use – Post Installation Use

Two Questions:
- What adjustments to the baseline performance are required?
- What measurements are required to determine post-installation performance?

The IPMVP - M&V Options

- To what extent can the retrofit be measured separately from other facility components?
- To what extent can performance variables be measured?

www.ipmvp.org
Four IPMVP Options

A. Partially Measured Retrofit Isolation
   1. With assumptions/stipulations
B. Retrofit Isolation
   1. Fully measured
C. Whole Facility
   1. or sub-metered part
D. Calibrated Simulation
   1. With software

Statistical Basis for M&V

- Degree-days = a measure of the need for heating or cooling in a building
- Heating degree-days (HDD) = $\sum (T_{\text{base-h}} - T_{\text{avg}})$
- Cooling degree-days (CDD) = $\sum (T_{\text{avg}} - T_{\text{base-c}})$

\[ (U A + C_p N V) = \text{slope} \]

\[ \text{HDD} (\circ C) \]

Regression Analysis

Linear Regression of Baseline Energy vs. HDD

\[ y = 20.789x + 693.63 \]

\[ R^2 = 0.9546 \]

\[ 0 \quad 2000 \quad 4000 \quad 6000 \quad 8000 \quad 10000 \quad 12000 \quad 14000 \quad 16000 \quad 18000 \quad 20000 \]

\[ 0 \quad 200 \quad 400 \quad 600 \quad 800 \quad 1000 \]

\[ \text{Total kWh} \]

\[ \text{HDD (°C)} \]
Variants of Regression Pattern

Define base year performance

- Utility consumption and derived data
  - electricity, power factor, fuels, water, others
- Independent variables
  - weather factors (HDD & CDD),
  - occupancy type, density and periods
  - Space conditions
  - Equipment (load) inventory
  - Operating practices
  - Equipment problems or outages

Adjustments

- Changes in weather or occupancy
- Changes in operating schedule
- Tenant improvements
- Changes in building function
Adjustments and IPMVP

Option

- **Option A**: partial retrofit isolation - many performance variables are stipulated
- **Option B**: retrofit isolation - adjustments applied in the performance model
- **Option C**: whole building - adjustments applied in the performance model
- **Option D**: simulation - adjustments built into the simulation

Option Selection

- project costs
- expected savings
- complexity and number of measures installed
- anticipated changes to post-installation facility or system usage
- tolerance for uncertainty or risk of savings being achieved
- risk allocation between the owner and the contractor

M&V Cost and Uncertainty

- How much uncertainty can we tolerate?
- The lower the acceptable uncertainty the higher the cost
**A Structured Approach**

- M&V Applied to Retrofits
- M&V Planning Process
- M&V Method Selection

**Define Post-EMO Period**
- Time
- Planned changes to base year conditions
- Conditions for comparison of base year and post-EMO period
- Non-routine baseline adjustments

**Develop Energy Performance Model**
- Select data analysis techniques
- Develop algorithms & equations
- Establish assumptions & stipulations
- Develop spreadsheets/ acquire software
**Test/Revise Performance Model**

- Quantify expected accuracy/uncertainty
- Assess budget impact of accuracy/uncertainty changes
- Define a cost effective level of accuracy/uncertainty acceptable to all parties

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**Define and specify metering equipment**

- Make use of available data
  - EMS, BMS, other systems
- Meter
  - Accuracy
  - Precision
  - Calibration
  - Commissioning

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**Define Ongoing M&V Activities**

- Frequency
- Meter reading and witnessing
- Data analysis
- Quality assurance procedures
- Report formats and content
Implement the EMOs

- Install energy efficient equipment
- Install M&V measurement equipment
- Commission new systems and equipment

Implement the M&V Plan

- Collect data
- Apply performance model
- Make non-routine baseline adjustments
- Report/document energy savings
- Calculate energy cost savings and GHG emission reductions as needed

Risk Factors

- Financial, Operational and Performance
- Assess potential impact
- Identify
- Assign &/or clarify responsibility for management and mitigation
**Financial Risk Factor**
- Interest rates
- Energy prices
- Construction costs
- M&V Costs
- Delays
- Major changes in facility

**Operational Risk Factors**
- Operating hours
- Equipment loads
- Weather
- Life of equipment
- User participation

**Performance Risk Factor**
- Equipment performance
- Maintenance
- Operation
Applying Price & GHG Factors to Energy Savings

- Use incremental (marginal) prices for
  - Electrical energy & demand
  - Thermal contract demand (gas, steam etc.)
  - Thermal energy
- GHG emissions factors (kg/TJ or kg/kWh etc.)
  - Provincial marginal or average
  - National marginal or average

Applying Energy Prices

- Need to know:
  - Energy saved (kWh, GJ)
    - By time-of-day for TOU rates
  - Demand saved (kVA, l/day, kg/hr)
    - For on/off peak periods
- Other factors:
  - Transformer credits
  - Demand ratchets
  - Power factor
  - Other discounts/surcharges