

Module 12: Quality Assurance



DEPARTMENT OF MINERALS AND ENERGY
DME-Danida Capacity Building in Energy Efficiency & Renewable Energy

Ensuring that audits comply with DME requirements

Learning Objectives



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- 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

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Audit Process

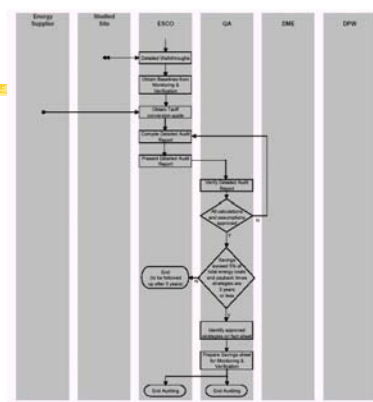


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Audit Process



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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

MJ/m²/year

VA_{average}/m²/month

Steps

- historical analysis
- collect building data
- demand profile
- walk-through
- tariff analysis

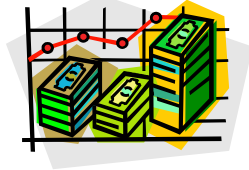
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Preliminary Audit Findings



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



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Detailed Audit



- | | |
|---|---|
| <ul style="list-style-type: none"> ■ Purpose <ul style="list-style-type: none"> ■ identify specific measures to reduce consumption, demand, cost | <ul style="list-style-type: none"> ■ Steps <ul style="list-style-type: none"> ■ examine site drawings ■ prepare load inventory ■ assess demand profile ■ assess all energy load areas ■ provide baseline criterion ■ assess tariff change opportunity |
|---|---|

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EMO Checklist



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



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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



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Planning, Implementation and Evaluation

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

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The steps in the PDC



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

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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

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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

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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

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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

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Loan Agreements



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

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ESCO Services



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

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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)

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Step 4: Contracting Options



- Traditional contract
- Extended technical guarantee/service
- Extended financing terms
- Guaranteed savings performance contract
- Shared savings performance contract

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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 (Chaufage)** - 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



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Savings Verification

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

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Working Definitions



- | | |
|--|--|
| <ul style="list-style-type: none">■ Measurement and Verification:<ul style="list-style-type: none">■ a process of quantifying energy consumption before and after an EMO is implemented to verify and report on the savings actually achieved | <ul style="list-style-type: none">■ Monitoring and Targeting<ul style="list-style-type: none">■ a management technique to "keep operations efficient", and to "monitor utility costs"-management strategies to drive energy costs downwards as a continuous improvement cycle |
|--|--|

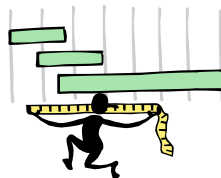
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Why Measure & Verify?



- 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



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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

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Determining Savings



$$\text{Savings} = \text{Adjusted Baseline Use} \\ - \text{Post Installation Use}$$

Two Questions:

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

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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

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Four IPMVP Options



A. Partially Measured Retrofit Isolation

- With assumptions/stipulations

B. Retrofit Isolation

- Fully measured

C. Whole Facility

- or sub-metered part

D. Calibrated Simulation

- With software

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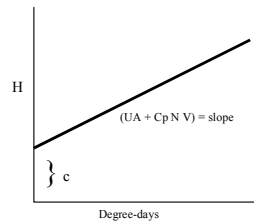
Statistical Basis for M&V



- Degree-days = a measure of the need for heating or cooling in a building

- Heating degree-days (HDD) = $\sum(T_{\text{base-h}} - T_{\text{avg.}})$

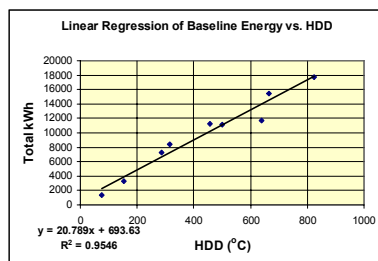
- Cooling degree-days (CDD) = $\sum(T_{\text{avg.}} - T_{\text{base-c}})$



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Regression Analysis



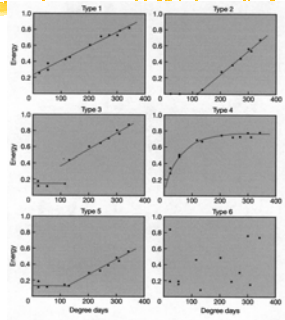
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Variants of Regression Pattern



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Define base year performance



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- 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

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Adjustments



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

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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

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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

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M&V Cost and Uncertainty



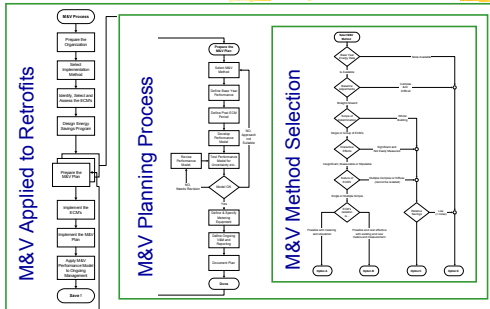
- How much uncertainty can we tolerate?
- The lower the acceptable uncertainty the higher the cost



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A Structured Approach



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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

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Develop Energy Performance Model



- Select data analysis techniques
- Develop algorithms & equations
- Establish assumptions & stipulations
- Develop spreadsheets/ acquire software

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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

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Implement the EMOs



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

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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

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Risk Factors



- Financial, Operational and Performance
- Assess potential impact
- Identify
- Assign &/or clarify responsibility for management and mitigation

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Financial Risk Factor



- Interest rates
- Energy prices
- Construction costs
- M&V Costs
- Delays
- Major changes in facility

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Operational Risk Factors



- Operating hours
- Equipment loads
- Weather
- Life of equipment
- User participation

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Performance Risk Factor



- Equipment performance
- Maintenance
- Operation

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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

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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

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