EUROPEAN COMMISSION
DIRECTORATE-GENERAL JRC
Institute for Environment and Sustainability
Renewable Energies Unit

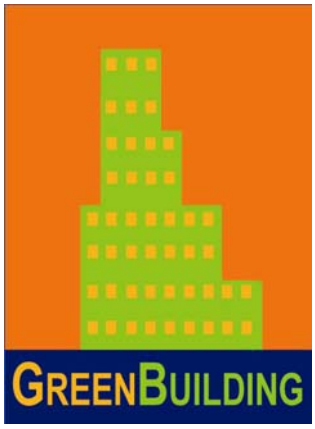
Ispra, 30 September 2005

THE EUROPEAN

GREENBUILDING PROGRAMME

ENERGY AUDIT GUIDELINES

Version 1



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1. INTRODUCTION

1.1 Background

An Energy Audit is an examination of an energy consuming equipment/system to ensure that energy is being used efficiently. In many ways, this is similar to financial accounting. Building manager examines the energy account of an energy consuming equipment/system, checks the way energy is used in its various components, checks for areas of inefficiency or that less energy can be used and identifies the means for improvement.
Energy audit is a top-down initiative. Its effectiveness relies largely on the resources that should be allocated to energy audit by the building management:-
a) Commitment on energy conservation and environmental protection;
b) Anticipation on the energy savings achievable; and
c) Aspiration of the improvement to corporate image by promoting energy efficiency and conservation.
It is important that the building management should be provided with the right perception of the benefits of the energy audit.
These Guidelines are targeted at commercial buildings, and to the energy consuming equipment/systems in particular.

1.2 Objectives

Energy Audit is an effective energy management tool. By identifying and implementing the means to achieve energy efficiency and savings, not only can energy savings be achieved, but also equipment/system services life can be extended and indoor quality could be improved. All these mean savings in money and possibly improve productivity.
Based on the principle of “The less energy is consumed, the less fossil fuels will be burnt”, both the buildings and the power generation companies will generate relatively less pollutants and by-products. Therefore, all parties concerned contribute to conserve the environment and to enhance sustainable development.

2. ENERGY MANAGEMENT OPPORTUNITIES

In Energy Audit, the means to achieve energy efficiency and conservation is technically more appropriate to be called Energy Management Opportunity (EMO), which will be used in the remainder of these Guidelines. According to the cost and the complexity for implementation, EMOs are classified as follows:

Category of EMO	**Capital Cost**
Cat I	Involves practically no cost investment and without any disruption to building operation, normally involving general house keeping measures e.g. turning off A/C or lights when not in use, revising A/C temperature set-points, etc.
Cat II	Involves low cost investment with some minor disruption to building operation, e.g. installing timers to turn off equipment, replacing T8 fluorescent tubes with T5 fluorescent tubes, etc.
Cat III	Involves relatively high capital cost investment with much disruption to building operation, e.g. adding variable speed drives, installing power factor correction equipment, replacing chillers, etc

3. HOW TO CONDUCT ENERGY AUDIT

3.1 General

The Energy Audit should be carried out by a competent person having adequate technical knowledge on Building Services (BS) installations, particularly Heating, Ventilation and Air-Conditioning (HVAC) Installation, Lighting Installation and any other BS Installations. This competent person is referred to as the “auditor” and a team of auditors forms the “audit team”. The number of auditors and time required for an audit depends on the audit scope and objectives. During the audit process, the auditor needs assistance and cooperation from the auditees, such as end-users, operation and maintenance (O&M) personnel, etc.

To gain a better knowledge of the building and its energy consuming equipment/systems, the audit team must collect information on the building operation characteristics and the technical characteristics of its various energy consuming equipment/systems. Its performances have to be identified through checking O&M records, conducting site surveys and reading metering records. The audit team will then identify areas that can be improved and write up an energy audit report on the findings for record purposes and for subsequent EMO implementation and follow-up actions. The flow chart on conducting energy audit is shown in *Figure 1* for reference.

3.2 Defining Scope of Energy Audit

The scopes of works and the available resources for conducting the energy audit should be determined. The available resources mean staff, time and budget. Recognising the extent of support from the building management, the audit team should then determine the scope of the energy audit such as the areas to be audited, the level of sophistication of the audit, the savings anticipated, any EMOs to be implemented, the audit result to be used as reference for improvement on O&M, the need for any follow up training or promotion of results achievable, etc. The plan for conducting the energy audit should then proceed.

3.3 Forming an Energy Audit Team

An audit team should be formed by:-
a) Determining the members of the audit team and their duties.
b) Involving the O&M personnel to provide input.
c) Facilitating meetings for sharing of information and familiarising among different parties.
Should in-house expertise or resources be regarded as not adequate, energy audit consultants should be employed. Many of the local BS consultants and tertiary academic institutions have the expertise on energy audit.

3.4 Estimating Time Frame & Budget

Based on the available resources, the time frame and the budget can be fixed. The budget is mainly built-up on cost of auditor hours from collection of information to completion of the audit report. The audit team should check whether they have adequate testing instruments as shown in **Appendix A**. In addition, the cost for employing BS consultants and/or tertiary academic institutions may be included, if so required.

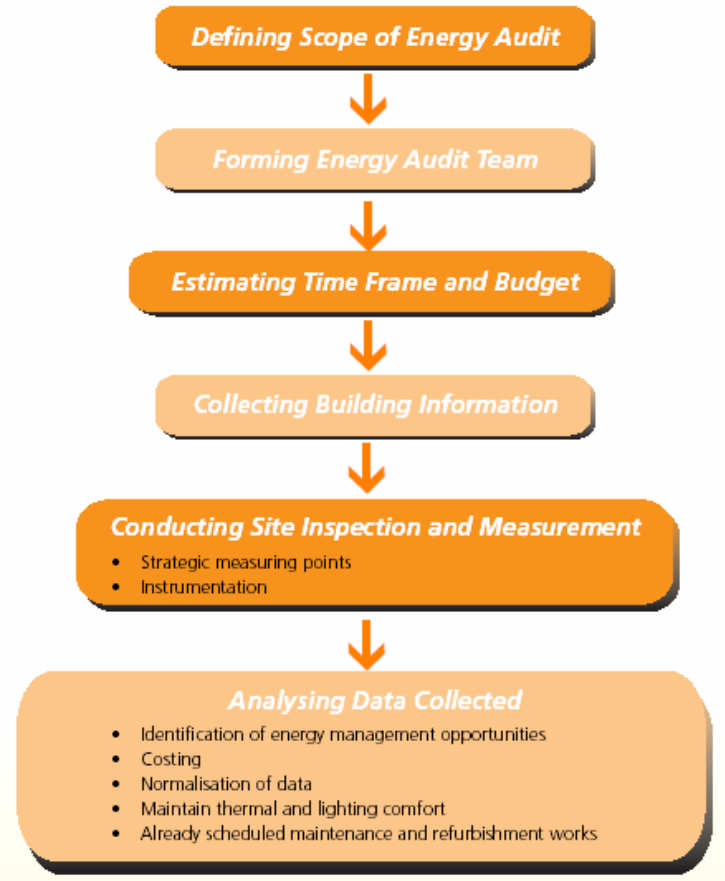
3.5 Collecting Building Information

The audit team should then proceed to collect information on the building. The information should include:-
a) General building characteristics such as floor areas, numbers of end-users, construction details, building orientation, building facade, etc.;
b) Technical characteristics of energy consuming equipment/systems, design conditions and parameters;
c) Building services design report with system schematic diagrams and layout drawings showing system characteristics;
d) Equipment/system operation records, including data logs of metered parameters on temperature, pressure, current, operational hours, etc.;

e) Record of EMOs already implemented or to be implemented;
f) Record of maximum demand readings;
g) O&M manuals and testing and commissioning (T&C) reports; and
h) Energy consumption bills in previous three years.

In general, it should be assumed that the building manager would have information on general building characteristics and the O&M personnel would keep the equipment/system technical and operation records. **Appendix B** shows some samples of log sheets.
The audit team should determine the appropriate parties to be approached for information collection, the need to discuss with these parties for familiarisation of the building, the equipment/ systems to be investigated and data verification and the need to discuss with selected end-users.
The audit team should consider issuing questionnaires to end-users to collect information on thermal comfort, lighting comfort, operational hours of individual floors/offices, electrical equipment and appliances, etc. A sample questionnaire is given in **Appendix C**.

Figure 1: Flow Chart on Conducting Energy Audit



After having collected all or the majority of the above information, the audit team will have better understanding of the building context and its energy consuming equipment/systems. With this information, the audit team can better plan subsequent audit activities and detect any missing important datum and arrange to obtain them.
At this stage of the audit, the auditor should be able to tell the characteristics of the energy consuming equipment/systems such as:
a) Type of chillers, their capacities and operational characteristics (refrigeration pressure/temperature, water flow rate/
temperature/pressure, etc.);
b) Type of HVAC systems, their components (fans, pumps, pipework, ductwork, etc.) and operating characteristics (flow rate, temperature, pressure, etc.);
c) Occupancies or usage for various equipment/systems;
d) Control mechanisms for various equipment/systems (controller, actuator, sensor, control logic, etc.);
e) Type of luminaires, their characteristics and control mechanisms;
f) Power distribution system characteristics;
g) Operational characteristics of lift and escalator installation (zoning, type of motor drive, control mechanism, etc.);
h) Operational characteristics of other energy consuming equipment/systems; and
i) Characteristics of the building.
The audit team should compare the operational characteristics against design or corresponding general engineering practices. The comparison can reveal if the energy consuming equipment/systems are operating per design or general engineering practice and identify the areas of inefficiencies. The parameters for comparison include the following:-
a) Chiller efficiency (Coefficient of Performance)
b) Motor efficiency (%)
c) Fan system power (kW per L/s of supply air quantity)
d) Fan efficiency (%)
e) Piping system frictional loss (Pa/m)
f) Pump efficiency (%)
g) Lighting power density (W/m2)
h) Lamp luminous efficacy (Lm/W)
i) Lamp control gear loss (W)
j) Efficiencies of various equipment e.g. boiler, heat pump,
etc (%)
The individual equipment/system module provides good reference figures for comparison purpose. For HVAC Installation, areas of inefficiencies could be identified from data logs of flow rates and corresponding changes in temperatures and pressures. For Electrical Installation, areas of inefficiencies could be identified from data logs of electrical currents and voltages. If relevant data logs are not available, measurements should be taken to obtain the data of possible inefficient equipment/systems. The numbers of measuring points would depend on the resources available.

3.6 Conducting Site Survey and Measurement

More activities should include the following actions:-
a) Proceed to plan the site survey for the areas and the equipment/systems to be investigated.
b) Allocate the work among the audit team members.
c) Assess if separate groups are needed for the areas and the equipment/systems. For example, the first sub-group for low floors, the second sub-group for mid floors, the third sub-group for high floors, so on and so forth. The grouping should also be based on the quantity of measuring instruments available.
d) Develop energy audit forms in **Appendix D** to record the findings.
e) Plan ahead on the site measurement to supplement or verify the information collected. The measurements should focus on equipment/systems that inadequate information is available to determine their efficiency and equipment/systems that appear to be less efficient.
Forms in **Appendix D** could be used in recording the measurements. Some data may have to be logged over a period.

3.6.1 Strategic Measuring Points

During the measurement, the sensors should be located at points that can best reflect the need or function of the controlled parameters. For example, for the office environment, a lux meter should be placed at about 0.8m above floor level
(or at level of the working plane) and a thermometer at about 1.1m (seating thermal comfort) above floor level and pressure and flow sensors in ductwork at points according to general engineering practice.
For measurement requiring interfacing with the stream of flow, the system may already have test holes/plugs or gauge cocks.
However, many systems may not have such provisions and the audit team may need to install the test holes/plugs or to use the ultrasonic type meter. In fact, it is impractical in most cases to install additional flow meter or gauge cocks in water
pipework. Under such circumstances, the audit team may have to make use of the existing ones available, e.g. gauge cocks before and after pump, coil, etc. to measure the pressure of the flow and to calculate the flow rate by referring to pressure/flow curves of pump, valve, pipe section, etc. If the original O&M manuals showing the pressure/flow curves are not available, make reference to those of similar size/rating.

3.6.2 Instrumentation

Whilst much data and characteristics on equipment/systems can be obtained from the O&M personnel, the information may not be adequate to provide a full picture of their operation. To obtain accurate operating conditions and operating performance of equipment/systems, the auditor should have the necessary measuring instruments to take readings of corresponding parameters such as temperature, pressure, flow, lighting lux level, running current, etc. A list of the commonly used instruments is given in **Appendix A**.

3.7 Analysing Data Collected

At this stage of the audit, the audit team has collected a lot of information on:-
a) Equipment/system characteristics obtained from site surveys;
b) Equipment/system performance data obtained from O&M log sheets;
c) Equipment/system performance data obtained from site measurements; and
d) Equipment/system operating conditions of equipment/systems based on design and/or general engineering practices.
Based on the above, the audit team should screen and spot the parameters with values and trends that deviate from what would be anticipated or required respectively. These are the potential
EMOs. However, they should take into account the analysis of the irregularities caused by changes in occupancy or other activities.

3.7.1 Identification of EMOs

To identify the improvement works for the potential EMOs, calculations should be performed to substantiate the improvement works by quantifying energy savings. Some of the typical findings in an audit, the corresponding EMOs and energy savings have been shown in **Appendix E**.

3.7.2 Costing

In evaluating the effectiveness of an EMO, the auditor has to calculate the payback period, net present worth or rate of return. Most calculations can be done using simple payback approach by dividing the EMO's capital cost by the cost of anticipated annual energy saving to obtain the payback period in years.
However, if there are appreciable deviations between the trends of energy cost and the interest rate or if the capital costs of EMOs are to be injected at different stages with different energy savings achievable at different times, the audit team may have to perform a life cycle cost assessment that can better reflect the cost effectiveness of EMOs. Some common calculations are shown in Appendix F.

3.7.3 Normalisation of Data

In the energy consumption bills, the measurement dates may not fall on the same day of each month. For more accurate comparison, particularly when different fuel types metered on different dates are involved, these data should be preferably normalised as figures on the common dates.

3.7.4 Maintaining Thermal and Lighting Comfort

Energy audits aim to improve efficiency but not to save energy by purely sacrificing the standard of service. An EMO should normally not downgrade the quality of service to that below common design standards. Examples of substandard level of comfort include room cooling temperature and air movement rate respectively higher and lower than the recommendations, excessive noise from equipment/systems causing nuisance, etc.

In the past, energy can be saved by limiting the fresh air supply to an A/C space. With renewed concerns on good indoor air quality, consideration to provide “adequate fresh air supply” should be a foremost thought when degrading to reduce fresh air supply.

3.7.5 Already Scheduled Maintenance and Refurbishment Works

When determining EMO, it is necessary to take into account the already scheduled major maintenance and refurbishment works. Therefore, when planning EMO implementation programme, the already scheduled major maintenance and refurbishment works may consider including some of the EMOs.

3.7.6 Annual Monthly Energy Consumption Profile

Based on the energy consumption bills over past years (preferably 3 or more), the auditor should estimate the annual energy use of the building. Graphs of energy consumption against different months of the year can be plotted, from which a pattern or general trend over a number of years can be seen.
These graphs can show normal seasonal fluctuations in energy consumption. More importantly, any deviations from the trend are indication that some equipment/systems had not been operating efficiently as usual, which warrant more detailed studies to identify if further EMO has existed.

3.7.7 Energy Utilisation Index/ Building Energy Performance

The Energy Utilisation Index (EUI), obtained by dividing the annual energy consumption by the Gross Floor Area (GFA), takes into account the difference in energy consumption due to difference in building floor areas and is used for comparison of energy consumption among buildings of similar nature. An ordinary office building usually has an annual EUI of 700 to 1, 100 MJ/m2 (200 to 300kWh/m2). The EUI should be also regarded as the Building Energy Performance (BEP). As there are different types of energy used in commercial buildings electricity, district heating, natural gas, LPG, diesel, etc. the BEP computed for buildings have to include all these forms of energy. Usually, EUI or BEP, if not identified as an index for a particular month, refers to the index for an entire year.
Appendix H shows the sample graphs in Energy Audit Report.
Appendix I shows the EUI/BEP of some Government office buildings.

4. SOPHISTICATION OF AUDIT

The sophistication of an audit refers to the scope and the extent to which investigations should be conducted and which findings should be analysed. Based on available resources, the size and type of building, and the energy audit objective, the auditor should adopt the energy audit of different levels of sophistication.

Under such terms, there are two types of audits:
a.) Walk-through Audit
b.) Detailed Audit
In summary, the Walk-through Audit involves a simple study of some major equipment/systems and the Detailed Audit involves a thorough study of practically all equipment/systems.

4.1 Walk-through Audit

Audits may deploy minimum resource to simply check for EMOs that are readily identifiable and to implement them to achieve savings immediately. Under such circumstances, the audit team should carry out a Walk-through Audit. It is the simplest type of energy audit and is the most basic requirement of the energy audit.
The audit should be conducted by walking through the building and concentrating on the major energy consuming equipment/systems such as chillers, large air handling units (AHUs), or common items usually with EMOs easily identifiable such as over-cooled spaces and T8 fluorescent tubes being used. Reference to record of equipment ratings, technical catalogue, O&M manuals that are readily available will be very helpful to quickly determine where equipment/systems are operating efficiently. Calculations, usually simple in nature, should be done to quantify the saving achievable from implementation of the identified EMOs.
The audit should be carried out in one day by either one auditor or one audit team, depending on the size and the complexity of the building and the scope of the audit. If the audit team wants to check more areas, more auditor-hours are required. Usually, simple instruments such as thermometer tube, multi-meters and lux meter will serve the purpose. A Walk-through Audit should, other than fulfilling the original objectives, give an overview of other areas with potential EMOs.

4.2 Detailed Audit

Alternatively, if the building management is highly committed to energy conservation and have allowed for adequate staffing and funding, a Detailed Audit should be adopted. The audit team should check practically the majority or all equipment/systems, identify as many EMOs as possible, classify them into different EMO categories, further study if more complex items are involved, formulate a plan for implementation and finally present it to the building management. This audit goes much beyond the Walk-through Audit. The auditor has to exercise more detailed planning. The auditor-hours could be about 5 to 10 times more, depending on the complexity of the equipment/systems involved and size of the building.

5. ENERGY AUDIT REPORT

The report should outline the objectives and scope of audit, description of characteristics and operational conditions of equipment/systems audited, findings in the audit, EMOs identified, corresponding savings and implementing costs, recommendations on EMO implementation and programme and any other follow-up actions.
This Section presents the suggested format for the report of a Detailed Audit. As the report is to suit for the need of the auditor, the auditor may choose to adopt the suggested format in whole or in part or adopt a totally different format. For Walk-through Audit, the auditor may trim down the report by deleting items not involved.

5.1 Executive Summary

The energy audit report provides the building management a quick overview of the scope of audit, EMOs identified, recommended actions justified by savings achievable and briefing on implementation plan. If there are EMOs of similar nature (e.g. replacement with electronic ballasts for lightings in different floors), they should be grouped under a common heading with cumulative savings shown. To draw the building owners' attention to the importance of implementing the EMOs, the cost of the estimated energy savings should be clearly identified.

5.2 Format of Energy Audit Report

5.2.1 Introduction

This part aims to describe the following topics:
a) The building audited - numbers of floors, floor areas, usage, occupancy, hours of operation, year built, etc., layouts and schematics to be attached as appendix;
b) Objectives, such as studying the building energy consumption with a view to identifying EMOs for implementation, setting target savings, considering long term energy management programme, etc.;
c) Scope of audit, covering the installations to be studied such as HVAC Installation, Electrical Installation, Lift & Escalator systems, Plumbing & Drainage Systems or any particular equipment/systems, the depth of the study, the parties involved (end-user, building management, O&M personnel, etc.); and
d) Members of the audit team, and audit consultant employed, if any.

5.2.2 Description of Equipment/ Systems Audited

This part aims to focus on the following issues:
a) Describe equipment/systems audited, their corresponding capacities and ratings, design conditions, etc., equipment schedules, schematics and layout drawings to be included as appendix.

b) Make use of information provided by the building management, O&M personnel and end-users and site surveys.
c) State the design conditions if known, and if not known the conditions adopted as base reference and calculations in the audit.

It should include the following contents:-
a) Zoning of systems according to building height or usage;
b) HVAC Installation for different areas – type of system e.g. VAV, CAV, FCU, etc.; types of controls; type and numbers of chillers, pumps, heat rejection methods, etc. and their locations; type of heating systems and boilers
c) Lighting Installation – type of lighting for different areas and type of control and zoning;
d) Electrical Installation – numbers of transformers and low voltage main switchboards and their locations and size or ratings of main distribution cables/busducts;
e) Lift Installation and Escalator Installation – capacity, zoning, quantity, floors/areas served and types of control, types of drive;
f) Plumbing and Drainage System;
g) Hot Water System – type of system; and
h) Other notable energy consuming equipment/systems.

5.2.3 Findings

This part aims to focus on description of the results of the site surveys and should include:-
a) Findings in a systematic format such as in order of systems
(e.g. first on HVAC Installation, then on Lighting Installation, etc.) or in order of floors (e.g. from lowest level to top floor), or in order of usage (e.g. general office, private office, common corridor, lift lobby, etc.);
b) Descriptions of floors/areas with special requirements (e.g. 24-hour operation, low space temperature for computer room, etc.);
c) Calculation on cooling load, heating load, lighting load, electrical load and annual energy consumption (detailed calculations should be included as appendix);
d) Findings on O&M procedures and practices; and
e) Preliminary identification of possible EMOs against corresponding findings.

The descriptions should focus on issues related to possible EMOs and provide systematic numbering to findings for purpose of easy cross-reference. **Appendix J** serves as references
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5.2.4 Analysis and Identification of Energy Management Opportunities

This part focuses on the detailed analysis and identification of EMOs and should include:-
a) Comparison on actual performances of equipment/systems against original design (if information available) and/or actual site measurements for any discrepancies and identify the causes thereof;

b) Possible EMOs and corresponding substantiations (calculations on achievable energy savings and detailed descriptions as appendix);
c) Implementation costs for EMOs (making reference to corresponding reference numbers assigned to the findings, detailed calculations, schematics and drawings included as appendix);
d) Comparison on the different solutions to the same EMOs,
as appropriate;
e) Classification of the EMOs into categories (Cat. I, Cat. II or Cat. III);
f) Listing of EMOs in a systematic format such as in order of system (e.g. first on HVAC Installation, then on Lighting Installation, etc.) or in order of floors (e.g. from lowest level to top floor) or in order of usage (e.g. general office, private office, common corridor, lift lobby, etc.);
g) Programme for implementation of the EMOs;
h) Identification of areas for further study, if any;
i) Indication of parties concerned in the implementation of EMOs and the difficulties that may encounter and general methodologies to overcome them; and
j) Initial investment and payback of each EMO in the summary.

5.2.5 Recommendations

This part aims to focus on:-
a) The initial investment and payback period of each EMO.
b) The summary of recommendations in a systematic order.
c) Grouping items of similar nature/location/usage together
or group according to their categories (Cat. I, Cat. II and Cat. III).

6. EMO IMPLEMENTATION

6.1 Management Support

The auditor/audit team will implement the EMOs identified to achieve the objectives of energy savings. Whilst the auditor/audit team may have the authority to implement some of them, particularly Cat. I EMOs, the energy audit report should be endorsed by the building management for Cat. II EMOs and Cat. III EMOs, so as to have more cooperation from end-users involved in the implementation of these EMOs.

6.2 Planning

After receiving adequate support from the building management, the audit team should proceed to plan how to implement the EMOs based on the energy audit report. The audit team should:
a) Check if the solutions to the EMOs in detail and if not complete the corresponding design;
b) Check if adequate staff resources would be available and if not employ an audit consultant to do the detailed design and specification for the works required;

c) Identify the roles and responsibilities of the O&M personnel, the building management, end-users and relevant parties concerned;
d) Discuss with all parties involved and inform them the audit objectives and the audit scope, providing them copies of relevant sections of the audit report as appropriate;
e) Organise meetings for the monitoring of EMO implementation (Setting up of an ad-hoc committee for overall coordination and better understanding);
f) Consider ideas and comments from parties involved on the proposed EMOs, as there may be areas that the audit team has not properly considered during the audit or there may be some areas, EMOs or constraints that the audit team has overlooked in the audit;
g) Take into account that a lot of work may have to be carried out outside office hours, in order to minimise disruptions to routine building operation; and
h) Take into account that a lot of lobbying may be worthwhile, in order to obtain end-users' support and cooperation.

The audit team would then proceed to:
a) Consolidate all these "After Audit" findings, reassess the proposed EMOs, make adjustments or even delete if necessary and amend relevant capital cost involved;
b) Work out a revised list of EMOs with energy savings, capital cost and remarks on parties involved and specific attentions for implementation;
c) Prepare a revised programme of EMO implementation, which should address the time required to procure the services/products, the constraints not yet resolved such as the agreement by end-users to carry out the works in their working areas;
d) Prepare a rough estimate of the time expected in resolving the constraints;
e) Refer the EMOs with unresolved administration constraints to the building management for comment and decision;
f) Obtain final endorsement from the building management of the proposed programme if necessary; and
g) Obtain endorsement of the revised programme from the building management.

Experience has indicated that communication with end-users involved, O&M personnel and the building owner is very important to the success of EMO implementation. Whilst the audit team may take much effort and time to convince these parties that the proposed programme will contribute to energy savings, which means less expenditure to the building, the audit team should carry out their work more efficiently by having a harmonious relationship with them. The management concept of "partnership" among all parties concerned will smoothen the implementation process.

6.3 Monitoring of Implementation

To ensure that the EMOs are implemented properly, the audit team has to monitor the works and participation of parties concerned.
The audit team needs to exercise control and adjust procedures from time to time, such as further negotiation with end-users on permitted working hours, settling site work conflicts with O&M personnel, processing payments to contractors, etc.

6.4 Performance Contracting

As an alternative to implementation of EMOs, the building management can employ a Performance Contracting service provider to do the work. The concept of Performance Contracting is that the service provider will design and implement the EMOs at a cost of a certain percentage of the total savings resulted from implementation of these EMOs. This contract approach should extend to the entire energy audit.

7. PUBLICITY AND TRAINING

Other than EMOs, the audit team may spot some issues of concern that need to be addressed for the sake of continual energy savings and sustainable development.
Continuing improvement on O&M is important, as equipment/systems under good operating condition would usually use less energy. Raising the technical know-how and the awareness on importance of good operation and preventive maintenance of O&M personnel would contribute positively to energy savings. In this connection, proper training is required.
The building management may have noticed end-users at large are not well aware of energy savings. Raise their awareness through more publicity, organising talks or campaigns on energy efficiency and conservation. In fact, much energy can be saved simply through a good housekeeping such as turning off unused equipment/systems.

An energy audit and subsequent implementation of EMOs should provide certain energy savings. However, in order to maintain these savings over time, the building management needs a long-term Energy Management Programme (EMP).
Firstly, the building management develops an Energy Policy and then makes a corporate commitment to energy efficiency and conservation as well as appoints a senior member as energy manager to take charge of the Building Energy Performance (BEP) and to develop energy efficiency strategy. To meet the policy, the building management defines the objectives and energy efficiency targets in terms of energy savings, sets time frames for achievement and allocates adequate staff and financial resources. The building management should develop in-house energy experts and should engage energy manager/energy consultant to look after energy issues. These experts and energy manager/energy consultant should plan for further or periodic energy audits, formulate an action plan for implementation of EMOs and consider the need for staff awareness training to be provided as appropriate. A budget for EMP should be established and based on all these activities.

8. ENERGY MANAGEMENT PROGRAMME

These activities should be regularly reviewed and the policy should be reassessed and redefined as appropriate. A not-cost-effective enough EMO may be implemented, when there are major retrofits associated with this EMO. An example is the availability of fresh water for heat rejection method. This kind of “long-term”
EMO can be implemented as an activity of the EMP.

During energy audit, the building management might have installed some meters to monitor energy consumption for certain equipment/systems. Whilst some of them will be removed after the audit, some could be remained as part of the equipment/ systems. There may be also areas that meters could not be installed, due to site constraints or operational constraints. As an activity of the EMP, the building management should install meters (permanent type) or make provisions for ready connection of meters for each main system, its sub-systems and its associated components. Based on these metering facilities, the building management should better assess the energy consumption in the long run.

To verify the amount of energy savings through the implementation of EMOs, especially Cat II and Cat III EMOs, Measurement and

Verification (M&V) are essential. The building management should record the required operational data for energy saving assessment whenever any retrofits associated with these EMOs are implemented. For example, in terms of housekeeping, the building management should record the effectiveness in execution of housekeeping procedures being laid down for a particular venue, before and after retrofit. Sample checks at regular intervals are expected.