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ENERGY ASSESSMENT GUIDE FOR COMMERCIAL BUILDINGS



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ENERGY ASSESSMENT GUIDE

FOR COMMERCIAL BUILDINGS

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USAID ECO-III Project

Energy Conservation and Commercialization (ECO) Program was signed between the Government of India (GOI) and USAID in January 2000 under a Bilateral Agreement, with an objective to enhance commercial viability and performance of Indian energy sector, and also to promote utilisation of clean and energy efficient technologies in the sector.

Following the enactment of the Energy Conservation Act 2001, ECO-I Project supported GOI in the establishment of the Bureau of Energy Efficiency (BEE). Support to BEE was provided to set up procedures and authorities, establish office facilities and assist in several activities leading to the development of BEE's Action Plan including thrust area such as the development of an energy auditor certification program.

ECO-II Project provided BEE with necessary technical assistance and training support to implement two thrust areas of the Action Plan. First was to develop the Energy Conservation Building Codes (ECBC) for the five climatic regions of India, and the second was to support Maharashtra Energy Development Agency in developing strategies for energy conservation and implementation of selected programs.

The major objective of the on going ECO-III Project Program is to assist BEE in the implementation of the Energy Conservation Act. The focus areas include the development of Energy Conservation Action Plan at the State level, implementation of the Energy Conservation Building Code, improvement of energy efficiency in existing buildings and municipalities, inclusion of energy efficiency subjects in architectural curriculum, enhancement of energy efficiency in small and medium enterprises, etc.

Since November 2007, International Resources Group (IRG) with support from its partners (IRG Systems South Asia, Alliance to Save Energy and DSCL Energy Services) has been implementing ECO-III Project by working closely with BEE, Gujarat Energy Development Agency, Punjab Energy Development Agency, international experts, academic institutions, and private sector companies.

Foreword

Electricity consumption in the commercial sector (which includes commercial and government buildings) in India at present accounts for about 8% of the total electricity supplied by the Utilities and this has been growing annually at about 11-12%, much faster than the average 5-6% electricity growth in the economy. This is mainly attributed to the ever-increasing energy intensiveness of new buildings, apart from the additional loads added in existing buildings.

Energy audit studies conducted in several office buildings, hotels, hospitals have indicated energy savings potential of 20-50% in electricity end uses such as lighting, cooling, ventilation etc. This potential has largely remained untapped for a number of reasons. The main reason has been the limited availability of expertise for carrying out energy audits in buildings. Secondly, there has been inadequate awareness of the energy audit process amongst the building owners and users, which limits opportunities to save energy costs. This Energy Assessment Guide for Commercial Buildings, developed under ECO-III project (a collaborative programme of the Government of India and USAID) makes a concerted attempt to address the second barrier.

I am sure the building owners and users would find this document very useful, and that it would facilitate the hiring of competent energy auditors and consultants.



Dr. Ajay Mathur
Director General

Date: 24th April, 2008

Bureau of Energy Efficiency, New Delhi

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Executive Summary

Energy cost is one of the major components in a commercial building operation. With the advancement of energy efficiency practices and technologies, it is possible to cut down energy cost significantly in the buildings without reducing the thermal comfort and productivity of the building occupants. This can normally be achieved by the building owners and managers by initiating a systematic energy assessment/audit of their building, followed by implementation of cost effective energy efficiency measures.

The basic purpose of developing this guide is to raise awareness of commercial building owners/managers on the benchmarking/energy audit/assessment process, and also guide them on the process of identifying and implementing energy savings opportunities that exist in their buildings. The guide also aims to provide useful inputs to the energy auditors and consultancy organizations to standardize their building energy audit/assessment approach and ensure quality assurance in carrying out the energy audits in commercial buildings.

The building energy assessment process presented in this guide gives the building owner a step-wise approach starting from pre-assessment of energy consumption and costs (including benchmarking) in the building to the hiring of a specialized energy auditor or energy service company to carry out an in-depth assessment. Through the assessment process, the building owner is likely to have better understanding of their building facilities' energy consumption levels and patterns, and the possible approaches through which they can reduce the energy consumption levels. The flexibility of selecting from three levels of energy assessment process, discussed in the guide, allows the building owner to choose the level of energy assessment that is appropriate to their needs, and contract energy specialist/auditors for the required services. The guide provides the owner with an overview of what each level of assessment entails that includes level of effort, data collection requirement for effective analysis, type of energy efficiency measures and their associated costs towards their implementation, and the expected energy savings.

Realizing that not every energy audit can be converted into energy efficiency project, this guide also introduces the concept of degree days to weather normalize energy consumption data. This is very useful if energy audits are going to be used as a source of reliable end-use energy consumption data for developing a framework for benchmarking energy performance of commercial buildings.

The guide also delves into the post-assessment issues that relate to the implementation of specific energy saving measures and capital-intensive projects identified through the assessment process. These include financing of measures/projects and deployment of energy service companies to secure energy saving monetary gains.

1. Introduction

In a major impetus to institutionalize energy efficiency in the country, the Government of India enacted the Energy Conservation Act in 2001. Under the EC Act 2001, the Government of India established Bureau of Energy Efficiency (BEE) in March 2002, a statutory authority under the Ministry of Power (MoP) to enact and enforce energy efficiency policies through various regulatory and promotional measures. BEE developed an energy efficiency Action Plan which focused on various thrust areas which include Energy Efficiency in Commercial Buildings, Energy Conservation Building Code (ECBC), Energy Managers and Energy Auditors Certification Program, and others.

Indian commercial building sector (which includes commercial and public buildings) has started to receive the attention of policy makers for the last 5-6 years. The building construction industry at present contributes about 10% of GDP, and is expanding rapidly at over 9% per year spurred largely by the strong growth in the services sector. Electricity consumption in the commercial sector in India at present accounts for about 8% of the total electricity supplied by the Utilities and has been growing annually at about 11-12%, much faster than the average 5-6% electricity growth in the economy. This can mainly be attributed to the increasing energy intensity of the existing buildings, apart from new buildings which are coming up rapidly all over the country.

BEE launched its first energy efficiency programme for existing buildings in 2002. Sample studies conducted in a few selected government buildings in Delhi under the programme, have identified energy savings potential of about 30% on average. In the on-going next phase, 17 more buildings in Delhi have been audited. Similar initiatives are being considered for public and

private buildings in the states, by the authorities as well as the building owners.

Building owners in India are facing significant challenges with the rising energy cost and decreasing availability and reliability of energy supply. Rising operating budgets are directly attributable to increasing energy costs for lighting, air conditioning and building services. But unlike many other operational costs, energy costs are controllable. Building energy assessments can assist building owners to learn more about their facilities' energy use and take steps to effectively manage the energy use for long-term savings.

The first step towards reducing energy consumption is becoming familiar with current energy use and learning how to make existing processes more energy efficient. By undertaking an energy assessment, a building owner can identify energy intensive systems and greatest potential for energy savings. All levels of building energy assessment provide the owner with a baseline of their facility's energy usage that can be compared to other facilities to set performance targets and determine future course of action. Energy assessment also gives the building owners the tools they need to provide accurate information for reporting energy consumption to internal and external entities.

Building energy assessment also identifies the energy efficiency measures (EEM) that can be implemented in the facility, and the cost savings that will be realized. Energy auditors or energy service companies (ESCO) can assist building owners by assessing the existing energy use and providing lists of both low- cost and no-cost measures and capital intensive energy efficiency measure that building owners can pursue to meet their energy efficiency targets.

1.1 Goals

Although a large number of building energy audits has been conducted in India, conversion of energy audits into actual projects is very low. The energy audit reports, which could have been used as a reliable source of primary data, have not been used for creating useful benchmarks of energy use in the commercial and public buildings. This can partly be explained because most energy audits fall into the category of “one size fits all” and are focused on laying the ground work for large capital intensive projects even though the country does not possess an organized energy services and financing sector that can implement the recommendations contained in some of the energy audits. Experience from around the world and in India has shown that there are many energy saving opportunities that can be identified in focused energy audits and which does not require a huge capital outlay and relies more on the technical knowledge, expertise, and experience of engineers and service providers. How does one systematically realize those savings and use energy audits in a way that will lead to better energy policy being formulated for the building sector are the major goals of this guide. By knowing what to expect from the audit process and implementing audit recommendations, owners will be better equipped to maximize the benefit of the energy assessment in realizing energy and cost savings. This guide provides the tools required to take the building owner through the necessary steps to set and achieve their energy efficiency goals.

Standardized reporting forms for different energy assessment will assist both building owners and auditors. Standard reporting forms will provide building owners a useful tool to use when specifying the type and detail of information they require to meet their goals of energy efficiency and reporting to government agencies. Auditors will benefit from the consistency that will be developed across projects, and also from having a clearer understanding of their client’s needs.

Standardized reporting forms will assist the Bureau of Energy Efficiency to create a collection of benchmarking information and best practices to assist building owners in optimal energy savings. This will facilitate the building owner to take advantage of information from a wide range of projects that occur under the energy assessment process and which vary from low- or no-cost to significant capital expenditures.

Other stakeholders in the building energy assessment process will also find this guide a useful tool. State Designated Agencies who wish to work with building owners can use this guide to build capacity at the individual and the state level. Energy consultants and auditors will be able to better serve their clients by using this guide to gain a fuller understanding of the full process for the building owner, and the building owner’s expectations from the assessment process.

1.2 Scope

The overall scope of this guide is to provide commercial building owners with the background information they need to contract with an energy services firm or auditor to provide a building energy assessment appropriate to their needs. The following section gives a broad overview of the status of energy assessment in India to provide building owners an understanding of the role played by government entities and private industry in the energy assessment process.

To give a complete overview of the building assessment process, the guide assists the building owner through the entire process in a chronological fashion. The process is divided into three sections; Pre-Assessment, Assessment, and Post-Assessment.

1.2.1 Pre-Assessment

The Pre-Assessment section includes all steps that are required leading up to the actual assessment

including: benchmarked indices for different types of commercial buildings, a screening tool to assess if a building energy assessment should be undertaken for the facility, the formation of an Energy Efficiency Committee, preliminary data gathering, a self assessment to determine the level of assessment required, and the steps required to find and hire an auditor/ consultant.

1.2.2 Assessment

The assessment section gives an overview of each level of building energy assessment, and what level of effort and results can be expected of each. Additional information is given on performance contracts as they relate to higher levels of assessment and on reporting requirements from all levels of assessment.

1.2.3 Post -Assessment

The post-assessment section provides information on how to implement and continue ongoing energy savings based on the results of the building energy assessment, including: implementation, operation and maintenance changes, measurement and verification, and the review process.

1.2.4 Additional Information

Additional information has been provided to ensure a successful energy efficiency process. In the

appendices of this document, samples and guides have been included to ensure that all technical elements of energy assessment are captured in the expression of interest, request for proposal and specification of reporting requirements. Some suggested references of additional technical guides and reports for measurement include:

- Book III and IV of National Certificate Examination for Energy Managers and Energy Auditors prepared by BEE
- ASHRAE Commercial Building Energy Analysis

These resources will help the building owners to be proactive and clear in specifying what they want from their energy efficiency program in terms of energy savings, costs, and improved aspects of the building function, such as better thermal comfort, while still meeting governmental reporting requirements.

1.3 Status of Energy Assessment in India

1.3.1 Energy Assessment Drivers

Legislation

In 2001, the Energy Conservation Act established the Bureau of Energy Efficiency (BEE) to

Steps for Implementing an Energy Efficiency Program

Pre-Assessment:

- Benchmarking and Screening to decide if audit necessary
- Preliminary data collection
- Formation of Energy Efficiency Committee
- Set performance target
- Determine level of assessment to pursue
- Expression of Interest
- Request for Proposal

Assessment:

- Data collection and analysis for:
 - Level I Assessment
 - Level II Assessment
 - Level III Assessment
- Performance contract
- Report

Post-Assessment

- Implementation
- Operation and Maintenance
- Measurement and Verification
- Review

Drivers for Energy Assessment

- Legislation
- Cost savings
- Availability of funding sources
- Corporate social responsibility

“institutionalize” energy efficiency services, enable delivery mechanisms in the country and provide leadership to energy efficiency in all sectors of the country. Through the introduction of the Energy Conservation Building Code 2007 (ECBC), BEE has taken steps to ensure that future construction will meet energy efficiency criteria. For existing buildings, these codes will apply for specific renovations/retrofits cited under the code. In addition for all specified buildings, which includes “buildings or building components that have a connected load of 500 kW or a contract demand of 600 kVA or greater,” reporting requirements for all included facilities are anticipated. At present this code is voluntary, but it is anticipated that it may become mandatory in due course. BEE has also instituted the National Energy Conservation Awards to encourage building owners to pursue energy efficient practices, and has categories for hotels, office buildings, hospitals and shopping centers [BEE, www.bee-india.nic.in]

Cost Savings

Building owners, facing rising energy costs, are seeking ways to reduce costs. Employing energy efficient practices and retrofits can be a simple, inexpensive and effective way to achieve operating cost reductions. Some retrofits may be more cost intensive initially, but the long-term energy savings provide building owners the needed financial justification for undertaking such large scale projects.

Availability of Funding Sources

Multiple funding sources may be available to building owners to perform energy assessments, both internal and external to the organization.

Internal funding may come from either the operating and maintenance (O&M) budget or from the capital improvements budget. The changes in energy cost could be immediately realized in the operating budget, so this project could be funded by O&M source. Many of the improvements may require capital funding, so this alternate internal budget may also be used to provide the required resources. Organizations may even wish to work outside of the existing budgetary constraints to borrow money for an energy cost reduction program if they feel that the savings in energy costs would make this a sound economic decision.

External funding sources are available from a variety of sources. Funding an energy assessment can be done as a part of a larger performance contract where the cost of the assessment and following implementation would be carried by an energy services company (ESCO). The resulting energy savings will be used to pay the implementation costs and the ESCO’s fees. Additional funding may also be available under programs such as the Kyoto Protocol’s Clean Development Mechanism which acts as means of channeling funds for greenhouse gas reduction from developed countries to developing and transition countries in exchange for Certified Emission Reductions to assist them in meeting their Green House Gases (GHG) reduction goals.

1.3.2 Corporate Social Responsibility

A growing trend in both the public and Private sector is Corporate Social Responsibility (CSR). CSR advocates that an organization behave as more than a means to increase shareholder value, but also consider its role in society and in safeguarding the environment – in other words its responsibility to external stakeholders. This obligation is seen to extend beyond their statutory obligation to comply with legislation. Businesses that wish to pursue CSR will be internally motivated to pursue energy efficiency not only as a means of saving

money, but also as part of its commitment to reducing greenhouse gas emissions and freeing valuable energy resources for the public good.

1.4 Role of Key Organizations

- **Bureau of Energy Efficiency (BEE):** One of the priority areas of BEE is to institutionalize energy efficiency services, promote energy efficiency delivery mechanisms, and provide leadership to improvement of energy efficiency to reduce energy intensity in the Indian economy. BEE is developing policies and programs through cooperation with stakeholders to create

national energy conservation programs. In support of these policies and programs, BEE may establish systems and procedures to measure, monitor and verify energy efficiency results in individual energy end-use sectors as well as at national level. By utilizing GOI funds, and multi-lateral, bi-lateral and private sector support, BEE implements the Energy Conservation Act and programs, and may like to take advantage of public-private partnerships as energy efficiency delivery mechanisms. To achieve these goals BEE is in the process of creating methods of monitoring compliance of designated consumers (presently energy intensive industries notified under the EC Act), promote standard procedures for

Examples of Different ESCO Models

- **Full-Service ESCO:** The ESCO designs, finances and implements the project and either guarantees energy savings or shares an agreed percentage of the actual energy savings over a fixed period with the customer.
- **End-Use Outsourcing:** The ESCO takes over operation and maintenance of the equipment and sells the output (e.g., steam, heating/cooling, lighting) to the customer at an agreed price. Costs for all equipment upgrades, repairs, etc. are borne by the ESCO, but ownership typically remains with the customer.
- **ESCO w/ Third Party Financing:** The ESCO designs and implements the project but does not finance it, although it may arrange for or facilitate financing. The ESCO guarantees that the energy savings will be sufficient to cover debt service payments.
- **ESCO Variable Term Contract:** This is similar to the full-service ESCO, except that the contract term can vary based on actual savings. If actual savings are less than expected, the contract can be extended to allow the ESCO to recover its agreed payment. A variation is the “First Out” model, where the ESCO takes all the energy savings benefits until it has received its agreed payment.
- **Equipment Supplier Credit:** The equipment supplier designs and commissions the project, verifying that the performance/energy savings matches expectations. Payment can either be made on a lump-sum basis after commissioning or over time (typically from the estimated energy savings). Ownership of the equipment is transferred to the customer immediately.
- **Equipment Leasing:** Similar to supplier credit, the supplier receives fixed payments from the estimated energy savings. However, in this case the supplier owns the equipment until all the lease payments, and any transfer payments, are completed.
- **Technical Consultant (w/ Performance-based Payments):** The consultant conducts an audit and assists with project implementation. The consultant and customer agree on a performance-based fee, which can include penalties for lower and bonuses for higher energy savings.
- **Technical Consultant (w/ Fixed Payments):** The consultant conducts an audit, designs the project and either assists the customer to implement the project or simply advises the customer for a fixed, lump-sum fee.

performance contracting to promote the use of ESCOs, leverage financial support from multi-lateral and bilateral agencies and domestic financial institutions, and coordinate with various agencies like CPWD, Ministry of Finance, financial institutions, and State-Designated Agencies.

- **State Designated Agencies (SDAs):** The SDAs notified by the respective State Governments are responsible for assisting BEE to carry out their mandate in each individual state. A full list of the SDAs and their contact information is included in Appendix A. Under the Energy Conservation Act, roles and responsibilities of the State Government are to [BEE]:
 - Amend the ECBC to suit the regional and local climatic conditions;
 - Establish a fund to promote energy efficiency and to implement the EC Act;
 - Prepare a sectoral energy database and provide the feed back to designated consumers and BEE and MoP;
 - Direct designated consumers to comply with the provisions of the ECBC, including reporting on energy usage or undertaking energy assessment if deemed necessary;
 - Compile information from designated consumers through annual statements on energy consumption, energy audit reports, and action taken on the report of energy audit;
 - Designate an agency to coordinate, regulate and enforce the EC Act within the State;
 - Take all measures necessary to create awareness and disseminate information for efficient use of energy and its conservation;
 - Arrange and organize training of personnel and specialists in the techniques for efficient use of energy and its conservation;

- **Energy Service Companies (ESCOs) and Energy Auditors:** ESCOs and energy auditors are private entities that are contracted by building owners to undertake energy assessment/ audit and/or implementation of energy efficiency programs. The agreement entered into by the ESCO and client have various structures, depending on the requirements of the client, capitalization and project management and technical strength of the ESCO.

1.4.1 Strategies for a Successful Energy Assessment and Efficiency Program

Although energy assessments lead to energy cost savings, they are not free. Building owners should be prepared to invest the initial cost for the assessment, remembering that the paybacks are relatively short providing attractive return on investments.

An energy assessment is the first step towards long-term energy efficiency, but the success of the assessment is dependent on the follow through of the building owner. Long-term reductions are only achievable by following the project through to the end and ensuring that training and operational improvements are not left out of the program.

The success of an energy assessment/ audit is directly related to the level of involvement that the building owner has in the project. During the inception of the project, hiring the auditor, data gathering, reporting, implementation and follow up, the active involvement of the building owner show the level of importance that is afforded to the project, ensuring the cooperation of all staff. This high level of involvement will also allow the owner to ensure that their required end results are clearly stated, decision are made expeditiously, and that all the information needed to achieve the desired result is made available in a timely fashion.

Energy reduction through energy audits has been a standard practice in industry for many years. Many energy auditors come from an industrial sector background, and due to their prior experience may have a stronger understanding of energy efficiency in relation to process load and systems rather than building energy efficiency. This can lead to audits that either underestimate the complexities surrounding energy use in facilities or put too much focus on the quantitative analysis of energy systems. Building owners should ensure that when seeking out a building energy assessment that the focus is the building itself (including building envelope), rather than the technical systems analysis. The building characteristics, operation and maintenance, scheduling of systems, opening hours, weather dependency of loads and occupants' habits and behavior are as important as technical analysis and testing of building energy systems.

In implementing energy efficiency measures, the building owner should consider if there is capacity within the organization to proceed, or if an ESCO should be involved. If there is sufficient capacity within the organization and if the organization is willing to finance the energy efficiency project, the building owner will retain the full energy savings rather than sharing them with an ESCO. This is often the case in low-cost/no-cost measures, or in capital-intensive measures that have extremely short payback periods. In these cases it may be to the building owner's benefit to contract only for those services required for a set fee and retain the energy saving. In cases where there is not sufficient internal capacity, an ESCO should be involved through a performance contract. Refer to section 4.2 Performance Contracts for more information.

2. Pre Assessment

2.1 Screening Tool

Before undertaking a building energy assessment, the organization should first determine if the assessment process will be successful in the current situation. For an assessment process to yield the expected energy efficiency results, certain criteria are required. The owner's motivation and objectives should be both strong and rooted in concrete evidence that energy efficiency measures will yield expected results. There must be a high level of commitment by the building owner to pursue an energy efficiency program, including the willingness to finance the recommendations from the assessment process. Without this level of commitment it is unlikely that the assessment process will proceed to the implementation phase.

The site itself must be appropriate for consideration. The energy usage and the energy costs of the site will help to determine if the site is a good candidate for assessment. Also criteria such as useful building life should also be taken into account. There is hardly any point in undertaking an assessment for a facility that is scheduled for decommissioning before the energy conservation measures implemented will complete the payback period.

Screening Questions

- Is there a strong commitment by the organization to realize energy/cost savings?
- Is there an energy champion at the facility?
- Are the energy or utility costs high?
- Is the facility to remain in operation for five or more years?
- Does the organization have its own funds set aside for energy conservation projects?
- Are there additional funding options available for the assessment/ audit and project implementation?

Two additional considerations are the presence of a “champion” and a willingness to consider “alternative financing.” A “champion” is a person within the organization who is likely to shepherd a project forward. This individual's personal commitment to the project will be required to ensure that the project not only takes off, but goes beyond the assessment phase into implementation and realization of energy reduction goals. Funding for not only the assessment process, but the implementation of energy saving measures may require the organization to consider “alternative financing” in the form of borrowing, carbon trading, or the use of performance contracts. An organization that is flexible in the method of financing their projects and is open to using one of these financing options, will have a much higher likelihood of reaping the benefits of the energy efficiency projects.

2.2 Preliminary Data Collection

If it is found that there is sufficient reason to proceed with an assessment through the screening process, the building owner or building manager dealing with energy consumption and cost should begin to gather preliminary data. This will assist the building owner to determine if enough information is available to proceed with an energy audit.

Preliminary Data

- Minimum of one year of energy bills
- Building information
 - Size
 - Age
- Construction
- Type of building
- Building use

General information regarding building characteristics, energy consumption records and operational knowledge must be available to proceed with an energy assessment. (Refer to Appendix B: Form 1, standard form for collecting energy and building information.) This form has been jointly developed by Bureau of Energy Efficiency and ECO-III Project. General building information can include building area, age and construction details. Utility bills showing a minimum of one year of monthly energy consumption data are required. Operational knowledge of the building, such as usage, cooling and heating practices and systems in use will be required for baseline assessment. If results from the energy audit are going to be used for benchmarking, it is important

that cooling and heating degree day or hours (see box below) information be also collected to conduct weather normalization. Appendix C offers a simple approach based on the US Environmental Protection Agency's eeBuildings model for baseline development and identification of initial no and low-cost opportunities. Without this level of information at hand, it may not be practical to proceed with the assessment process.

2.3 Energy Benchmarking

Energy management in commercial buildings has evolved over a period of time. One key aspect of this comprehensive approach to energy management is a focus on setting goals and

Heating and Cooling Degree Days [WRI Report, 2003]

Climate, specifically the historical annual values of cooling degree-days (CDD) and heating degree-days (HDD), affects building energy consumption. An office building located in Kolkata, for example, will typically use significantly more energy on an annual basis than an office building of similar size and orientation located in Bangalore. The Energy Assessment techniques employed by an expert should account for these climatic differences. Within a given location over any given year, buildings may also be exposed to relatively severe or mild weather as compared to historical averages. Energy Assessment techniques should factor out or weather normalize this impact.

A degree day is a measure of the average temperature departure from a human comfort level of 18°C (65°F). The concept of degree days is used primarily to evaluate energy demand for heating and cooling services. Degree day indicators are widely used in weather derivatives, energy trading, and weather risk management.

Using a base temperature of 18°C, cooling degree days (CDD18) are defined as $(T-18)^{\circ}\text{C}$ where T is the average temperature of a given day equal to or higher than 18°C. Thus, a day with an average temperature of 26°C will have 8 degree cooling

days. Heating degree days (HDD18) are calculated in a similar fashion. Heating degree days are defined as $(18-T)^{\circ}\text{C}$, where T is the average temperature equal to or lower than 18°C. Accordingly, a day with an average temperature of 12°C will have 6 degree heating days. For both heating and cooling degree days, average temperature of a particular day is calculated by adding the daily high and low temperatures and dividing by two. Thus, if the daily high temperature is 20°C and the daily low temperature is 10°C, then the average temperature is 15 (resulting in 3 heating degree days).

Heating and cooling degree days are calculated in a cumulative fashion. For example, cooling degree days for a weather station with daily average temperatures during a five-day period of 24, 27, 18, 20, and 29 are 6, 9, 0, 8, and 9 (using 18°C baseline). This adds up to a total of 32 degree cooling days over the period. To calculate the degree cooling days of an entire year, the degree day calculations of all 365 days are simply summed. Naturally, heating degree days accumulate primarily during the winter, whereas cooling degree days tend to accrue during the warmer summer months. For more information on annual degree days in selected Indian cities, please refer to Appendix D.

measuring against these goals, a process that is often referred to as energy benchmarking.

End use energy benchmarks are normally expressed as Energy performance Index (EPI), helpful in comparing the energy performance of similar buildings. EPI is calculated by dividing the annual energy consumption by total built-up area of the building. This Benchmark is helpful in understanding where you stand in terms energy performance and based on that, you can take decisions as how to improve the performance further. Benchmarks for the best possible performance of existing buildings can be used as a prescription for new buildings.

Summary: Key Findings of the Benchmarking Study

Bureau of Energy Efficiency in partnership USAID ECO-III Project conducted the energy benchmarking study for commercial buildings. The average benchmarking studies for different building types (along with sub-classifications) are shown in Table 1.

2.4 Energy Efficiency Committee

The Energy Efficiency Committee plays a vital role in ensuring the success of an energy efficiency program. This Committee is brought together to oversee the assessment, implementation, and review of the energy efficiency program. The presence of key stakeholders on the committee signals to the organization that there is strong commitment, and provides required support to the selected project champion. This committee should include representatives from all associated departments from various levels, and report to top-level management. The role of all the parties should be clearly defined (participatory, advisory, approval). Some potential committee members are the designated project champion, building owner, operation and maintenance staff, financial specialist, technical specialist, and other concerned personnel.

The role of the committee may not end with the assessment process, but may continue during the post assessment period. The

Table 1: Averages for different Commercial Buildings

Count	Building Type	Built-Up Area, [m ²]	Annual Energy Consumption, [kWh]	Benchmarking Indices	
OFFICE BUILDINGS				[kWh/m ² /year]	
145	One shift Building	16,716	20,92,364	149	
55	Three shifts Building	31,226	88,82,824	349	
88	Public Sector Building	15,799	18,38,331	115	
224	Private Sector Building	28,335	44,98,942	258	
10	Green Buildings	8,382	15,89,508	141	
HOSPITALS				kWh/m ² /year	kWh/bed/year
121	Multi-specialty Hospitals	8721	24,53,060	378	13,890
18	Secondary Government Hospitals	19,859	13,65,066	88	2,009
HOTELS				kWh/m ² /year	kWh/room/year
89	Luxury Hotels – 4&5 Star	19,136	48,65,711	279	24,110

Source: Preliminary Results from BEE -ECO-III Benchmarking Study

Energy Efficiency Committee can monitor the implementation process to ensure all key tasks are being followed through by internal staff and contractors. They can also be involved in helping establish a reasonable measuring and verification process with respect to performance contracts. It is also recommended that they provide an ongoing review of energy efficiency measures to ensure existing measures are being undertaken fully, and that new measures implemented are periodically reviewed and considered.

Recommended Energy Efficiency Committee Members are:

- Designated project champion
- Building owner/operator/ manager
- Operation and maintenance staff
- Financial specialist
- Technical specialist
- Other concerned personnel

Table 2: Self Evaluation for Determining Level of Energy Assessment Required

<p>Level I Assessment</p> <p>Preliminary Energy Use and Walk Through Analysis</p>	<p>Purpose for undertaking:</p> <ul style="list-style-type: none"> • Gain a full understanding of how energy is being consumed and the associated costs • Report on energy use to internal or external stakeholders • Find energy conservation programs for immediate and future consideration • Identify projects for future energy reduction • Set targets for energy reduction 	<p>Results:</p> <ul style="list-style-type: none"> • Baseline of energy use • Forecast future energy use based on current/historical consumption • Identify no/low cost measures for energy reduction • List of potential projects for future investigation • Detailed benchmarking for accurate comparison to other facilities and own past performance • Prepared for next level of assessment
<p>Level II Assessment</p> <p>Energy Survey and Analysis</p>	<p>Purpose for undertaking:</p> <ul style="list-style-type: none"> • Desire to take advantage of energy and cost savings from a wider range of projects • Create an full energy conservation program 	<p>Results:</p> <ul style="list-style-type: none"> • Evaluation of all potential energy conserving operational changes and capital investments available • Listing of capital projects that require further investigation prior to implementation • Prepared for next level of assessment
<p>Level III Assessment</p> <p>Detailed Analysis of Capital Intensive Measures</p>	<p>Purpose for undertaking:</p> <ul style="list-style-type: none"> • Desire to undertake significant capital projects to improve the energy efficiency based on projects identified in previous levels of assessment • May include gaining access to external financing under performance contract 	<p>Results:</p> <ul style="list-style-type: none"> • Detailed information provided so that owners have a high level of confidence in decision making regarding significant capital investment • May include implementation of capital intensive EE measures under performance contract.

2.5 Self Evaluation

There are three levels of building energy assessments [BEE, www.bee-india.nic.in]. Each level is designed to meet specific needs of the building owner. For each level of assessment, the level of effort and expertise required differs. Each of the three types are briefly described below:

- **Level I Assessment:** Preliminary Energy Assessment; simple assessment based on available documents and information, physical inspection, and staff interviews to create a baseline and identify obvious energy efficiency measures which are easy to implement
- **Level II Assessment:** Comprehensive Energy Assessment; thorough review of data, existing and newly gathered, to identify all energy saving measures and identify high potential measures for further investigation
- **Level III Assessments:** Detailed Analysis of Capital Intensive Measures; also known as Investment Grade Audit used to give a detailed assessment of costs and benefits derived from capital intensive energy conservation measures

Each level of assessment builds upon the previous levels. This means that a building owner commissioning a level II or III assessment would be realizing all the benefits of the lower levels

of assessment as well. To assist building owners determine the level of assessment they require, a self evaluation tool [BEE, www.bee-india.nic.in] has been provided. This self-evaluation tool is based on the purpose for conducting the assessment and the final results that the building owner hopes to achieve. This tool is only a guide to give a general idea of which of the three levels of assessment is most appropriate. The lines between the levels of assessment are not rigid, and building owners can use their discretion when requesting consulting services to include requirements from higher levels of assessment if required.

2.6 Expression of Interest

The Expression of Interest (EOI) is used to shortlist energy auditors/ consultants for carrying out energy assessment on technical criteria and experience. Energy Consultants and ESCOs are invited to submit information describing their company background and experience for evaluation. Once the short list is formed, the included companies will be the only companies allowed to bid on future work related to the project. This process allows the building owner to ensure that they are selecting from the consultants who are qualified to meet the needs. The consultants benefit as they find out early on in the process if they will be considered, rather than to go through the onerous process of preparing a full project proposal without the certainty of knowing whether they meet the clients requirements.

EOI at a Glance

Purpose: To shortlist qualified ESCOs and energy auditors.

Qualifications to be considered:

- Accreditation of the firm
- Certified energy auditors on staff
- Audit instruments available
- Financial stability of firm

- Experience in energy auditing
- Experience in building energy efficiency projects
- Experience in similar projects
- Performance contract experience (for Level III only)

Evaluation: To be done by Energy Efficiency Committee

The EOI is a significantly simpler submission than the request for proposal which will be discussed in the following section. The EOI focuses more on company qualifications than proposed future work. The information to be included by interested energy consultants is general company information, company information specific to relevant projects, and key staff information.

The Energy Efficiency Committee should be involved in evaluating the EOI by applying the predetermined selection criteria. It is important that all committee members understand that the evaluation process is not applying a rigid checklist of criteria. Rather evaluation criteria provide a flexible guideline that allows the committee to select the best possible selection of Energy Consultants and ESCOs. However, the process needs to be transparent, and feedback to firms who are unsuccessful in the EOI process explaining the committee's decision will help firms to focus on developing internal capacity for future projects.

Evaluation criteria for the selection of an energy consultant or ESCO should be used to

ensure that the company is reliable and capable of performing the needed level of assessment. Some criteria that may be applied in the evaluation include:

- Accreditation of Firm by BEE, PCRA or SDA
- Number of certified energy auditors with the firm
- Audit instruments available
- Last 3 years annual turnover
- Experience in energy auditing
- Experience in building energy efficiency or similar activities
- Performance contracting experience

For objective criteria, a minimum acceptable requirement may be set, such as in accreditation of the firm or annual turnover. For subject criteria, a ranking or scoring system conforming to the requirements of the organization may be developed.

Sections to be included in an RFP

- Project background
- Facility location
- Buildings to be audited and its area
- Scope of work
- Detailed tasks, including any special analysis and the audit format (e.g. level of audit to be undertaken)
- List of deliverables and descriptions (e.g. preliminary list of projects, draft and final energy audit, preparation of performance specifications)
- Energy audit schedule (to include start date for audit, due dates for deliverables)
- Site visit and/or pre-bid meeting
- Evaluation criteria

Evaluation Criteria for RFP

- Accreditation of the firm
- Specific experience of the firm
 - Experience in similar projects
 - Experience in related projects
- Qualification of key staff
 - Team leader
 - Project manager
 - Electrical engineer
 - Mechanical engineer
- For performance contracts only
 - Experience in performance contracts
 - Experience in Measurement and Verification (M&V)
- Annual turnover

2.7 Request For Proposal

The Request for Proposal (RFP) is the process by which the building owner solicits proposals from the short listed companies selected through the EOI. The proposals will be evaluated to determine which firm will be hired for the energy assessment project. Short listed companies will be invited to submit proposals based on pre-defined criteria provided by the owner. The successful bidder is selected through a competitive bidding process utilizing both technical and financial criteria for the basis of selection.

2.7.1 Scope of the RFP

Development of the RFP is a critical step for the building owner as they must communicate clearly to the prospective firms the requirements of the assessment. The owner must include a clear and concise detailing of the work to be done and reports to be provided [BEE, www.bee-india.nic.in]. An RFP should begin with the background of the project, giving a brief description of building history and use, reason for undertaking an assessment and overall expected outcomes. This should be followed by the facility location and general information on the buildings to be energy assessed, such as building area and facility use. Next, the scope of work should give an overall framework of the project.

Expanding on the scope of work, detailed instructions on the tasks to be undertaken as a part of the assessment should be listed, including any special analysis and the assessment format, such as [ASHRAE 2004]:

- At least two years' worth of utility bills be collected and the data be recorded in a specified format for benchmarking purposes.
- A clear graphical presentation of annual utilities consumption and cost data should be constructed for presentation in the introduction of all assessment reports.

- An inventory of all energy-using equipment, including the capacity and rated consumption data for each, should be developed.
- Methods of measurement and systems requiring special focus to be specified if required.
- Service levels that are desired should be listed if know.

This section should describe the level of assessment to be undertaken and basic audit protocols to be followed.

The RFP should list the required deliverables from the assessment. This may include preliminary list of projects, draft and final energy reports, or preparation of performance specifications. This is the section where the specific contents required in the assessment report should be detailed. A schedule for the energy assessment should be set by the building owner, including start date for assessment, and due dates for deliverables.

The roles and responsibilities of all involved parties need to be clearly stated in the RFP and award process. This can include the role of the building owner, Energy Efficiency Committee, auditor/ consultant or ESCO awarded the work, sub-contractors, financing agencies or any other outside parties who will play a role in the project. The members of the Energy Efficiency Committee should be set out, designating staff positions to be represented on the committee. The building owner carries the additional responsibility of ensuring the full cooperation of all staff during the assessment process.

The RFP should include detailed instructions to the bidders regarding the format of responses that will be accepted, and the deadlines. The Energy Efficiency Committee may choose to use a standard form to be completed by the bidders to assist in their comparison of responses. Requiring a site visit that ensures a higher quality of submissions as the bidders will have a better

understanding of the work to be undertaken by the bidders. It is advisable to schedule only one site visit or pre-bid meeting where all bidders are present so that all are presented with exactly the same information. The date, time and location of the site visit and pre-bid meeting should be included in the RFP. Also the evaluation criteria to be used should be made clear in the RFP, allowing the bidders to structure their responses accordingly. Please refer Appendix E for RFP Outline for Commissioning Building Assessment.

2.7.2 Evaluating the RFP Responses

Evaluation of the RFP is a complex task in which the ability of the bidder as well as the proposal itself must be evaluated. Even though many aspects of the company experience and staff qualifications are evaluated during the EOI, it is important to revisit these criteria during the RFP evaluation. The evaluation done in the EOI process is to ascertain whether each firm met minimum requirements. In the RFP process the evaluation given is comparative in nature and is used to determine that the most qualified and capable firm for awarding the work.

The Energy Efficiency Committee should ensure that the bidder is both qualified and has the resources available to provide the services in the proposal. The bidders will be required to provide specific experience of the consultants firm related to the project such as education and specialization, experience in energy audit/certified energy auditor, and experience in validation & Performance Measurement and Verification (PMV) for Level II and III assessments, and certifications. Experience in similar assignment to investment grade energy studies in similar buildings with similar HVAC and control systems and other relevant assignments should be supplied to demonstrate the firm's experience. In particular the supplied information should demonstrate the ability to :

- Identify energy saving measures and design solutions
- Procure and install energy efficiency equipment
- Manage the overall project
- Monitor energy savings from energy efficiency projects
- Provide ongoing support, service and training
- Carry out detailed feasibility study of sites
- Including access to availability of energy monitoring equipment
- Annual turnover and financial parameters
- Experience in buildings sector
- Performance contracting experience for Level III assessments

Evaluation of the proposed key staff assigned to the project is also necessary. Qualifications and competence should be considered for each of the key persons such as team leader, project manager, electrical engineer, and mechanical engineer. It is also important to assess if the firm has adequate staffing levels to dedicate the required staff to the project as outlined in the proposal. For example, if a proposal has a very short time line with significant staffing hours required, the owner should verify that adequate staff have been identified in the proposal to meet the submitted deadlines. Also it is important that detailed information be given on any sub-contractors to be used, including the proportion of the project for which they will be responsible so that the proposal can be fairly evaluated.

In addition to evaluating the consulting firm and their staff, the content of the proposal should also be thoroughly evaluated. The RFP should have included a complete list of the expected activities and deliverables from consultant. During the evaluation process it is important that the evaluation committee take care to ensure that the evaluation committee take care to ensure that the proposal covers all points included in the

RFP, and demonstrates that the consultant has a full understanding of the requirements of the building owner. For critical tasks, the committee may refer to time lines and staff allocations provided to determine if adequate resources would be applied to those tasks. The committee should also take into consideration services that are offered in the bid that go beyond the scope of the original RFP and may add value to the project.

Financial evaluation should also play a role, once it is certain that all technical requirements

have been fulfilled. Evaluation of the proposed expected minimum energy savings is also important. It may be tempting for energy savings to be overstated by the bidder in hopes of attaining the contract. The veracity of any claims should be ensured, which is why a technical and financial advisor on the evaluation committee is recommended. This is even more critical in the case of a performance contract where the benefit to the building owner is linked to the cost savings achieved through the energy efficiency measures.

3. Levels of Energy Assessments

3.1 General information

There are three levels of assessment, varying in detail and comprehensiveness. Each level of assessment builds upon the previous level, meaning that all the requirements for data collection and analysis to be undertaken in the previous levels are included as a part of higher levels of assessment. For each level; the purpose of the level of analysis, data requirements and gathering guidelines, and analysis are described in the following sections. As a general rule, any level of assessment should include analysis of general building and energy use, description and analysis of the energy using systems, and an engineering and financial analysis [ASHRAE 2004].

3.1.1 General Building and Energy Information

The general description of the commercial building includes the age of the building, location and orientation, number of stories, what materials the building is constructed of, and how it was constructed. The complete building area should be listed, and further broken down into areas of specific usage. Each of these areas should be described by function, such as office space,

storage, etc., hours of use and area. The original intended use of the building should be considered, as changes to the building function may contribute to inefficiencies in energy use. Also operational and maintenance practices should be considered with respect to their impact on energy efficiency.

Analysis of energy and related costs should be based on a minimum of two years of utility bills. Energy use should be summarized on an annual basis and an energy use index of kilowatt hours per square metre should be calculated. Over the same period, the cost such as energy should be evaluated and a cost index such as cost per square metre is calculated. These energy and cost indices can be used to benchmark the building to other similar buildings.

3.1.2 Energy Using Systems

Energy Using Systems are:

- Building envelope
- Lighting
- Heating Ventilation and Air Conditioning
- Hot water
- Mechanical systems
- Other system

General Building and Energy Information

- | | |
|---|--|
| <ul style="list-style-type: none"> • Building information <ul style="list-style-type: none"> • Building type description • Overall building use • Area • Breakdown of building use: <ul style="list-style-type: none"> ◦ Function ◦ Hours of use ◦ Area • Use different from original design | <ul style="list-style-type: none"> • Operation and maintenance • Energy and cost information <ul style="list-style-type: none"> • Energy analysis <ul style="list-style-type: none"> ◦ Use ◦ Energy use index • Cost analysis <ul style="list-style-type: none"> ◦ Average utility costs ◦ Cost index • Benchmarking |
|---|--|

Within the building, energy consumption can be broken down by energy using systems. The analysis of each energy using system should include:

- Description of the system and components
- Energy use analysis
- Cost analysis

The building envelope is the exterior sections of the building that includes walls, roof and windows. These components are critical when consider with respect to interior building function and have significant impact on the other two major energy consuming systems; lighting and HVAC (heating, ventilation and air conditioning). Dependant on the building function, other systems may also be major energy consumers, such as heating water, mechanical systems for pumping water or running lifts, etc.

Guidelines on system level data collection and analysis is given in Appendix F.

3.1.3 Engineering and Financial Analysis

The final result of the energy assessment should provide the building owner with information that

will allow them to improve the energy efficiency of the building. The analysis of the energy use and cost data collected in the previous sections should be summarized, and significant findings explained.

A list of recommended energy efficiency (EE) measures should be provided for the consideration of the building owner. Each recommended measure should include a description of how the measure can be implemented, the associated energy and cost reductions, the cost to implement, and measurement and verification required to test the effectiveness of the measure. In some cases repairs to the existing building are required to realize the full potential of the EE measures.

The final report should provide the building owner with a baseline which is the current level of energy utilization and associated costs. Based on benchmarking to other facilities and assessment of the existing electricity consuming systems, the auditor/consultant should provide an ultimate target for energy reduction. This is a long-term goal for energy reduction and may not be achievable by the recommendations indicated in the assessment. A comparison between the

Table 3: Comparison of Levels of Assessment

LEVELS OF ASSESSMENT	I	II	III
Development of energy cost indices	√	√	√
Benchmarking to other facilities	√	√	√
Establishing energy use targets	√	√	√
Space function analysis of changes to building use	√	√	√
List of low-cost/no-cost measures	√	√	√
Preliminary list of EE measures for further study	√	√	√
Comprehensive list of EE measures for further study		√	√
Assessment of practical EE measures and recommendation of feasible measures for Level III assessment		√	√
Preliminary design of feasible EE measures			√
Detailed analysis of EE measures, including financial and risk analysis			√
Implementation plan for EE measures			√

baseline, energy savings from the recommended EE measures and the ultimate target should be provided.

3.2 Level I - Preliminary Energy Assessment

The Level I - Preliminary Energy Assessment has multiple purposes. Firstly it is used to establish an initial baseline of energy utilization based on previous months/years records. This information is useful for gaining an understanding of the amount and type of energy being consumed by the facility and the associated costs. Secondly it

identifies low-cost/no-cost energy reduction measures and potential projects for future investigation. This level of analysis can be used for as a starting point to proceed to higher levels of assessment, reporting purposes or benchmarking.

Data is collected in two ways for this level of assessment, through existing documents and through physical inspection of the facility. General information such as building use and area, and two years of energy consumption records, are the necessary information. Also a search within region for similar buildings that are also tracking energy utilization may be undertaken for benchmarking.

Engineering and Financial Analysis

- | | |
|--|--|
| <ul style="list-style-type: none"> • Analysis of energy use and costs • Recommended EE measures <ul style="list-style-type: none"> • Description • Energy and cost savings • Cost to implement • Pay Back Period • Repairs required for EE measures • Measurement and verification for monitoring | <ul style="list-style-type: none"> EE measures, and monitoring costs • Energy analysis summary <ul style="list-style-type: none"> • Baseline energy use and cost • Ultimate energy target • Reductions from recommended EE measures • Comparison of baseline, recommended EE measures and ultimate target |
|--|--|

Level I – Preliminary Energy Assessment - Specific Activities

- | | |
|---|--|
| <ul style="list-style-type: none"> • Determine building's total area and primary use • Collect data based on a minimum of two years of utility bills • Summarize data <ul style="list-style-type: none"> • Assess utility rates and potential savings • Analyze irregularities in use patterns • Brief walk-through survey of the facility including: <ul style="list-style-type: none"> • Construction • Equipment • Operations and maintenance • Meeting with building owner/Manager, staff and occupants | <ul style="list-style-type: none"> • Develop energy use and cost indices • Establish target energy use and indices • Breakdown of energy use by energy type and major end uses, if sub-metering available • Benchmarking to specific comparable facilities, if benchmarked data is available • Summary of any problems identified during walkthrough, including operation and maintenance • Identify and list low-cost/no-cost measures • Identify potential capital projects for further study • Report |
|---|--|

purposes. Physical inspection of the facility is used to increase familiarity with construction, equipment, and operation and maintenance. Anecdotal information from interviews of the owner/operator, staff and occupants can provide important information at this stage.

The analysis of this data will provide basic information on energy usage by energy source, consumption patterns and costs for total energy use and broken down by fuel type. The analysis of the gathered data will be used by the auditor/consultant to identify low-cost/no-cost changes to the facility, operation and maintenance procedures, and calculate associated cost reductions. As well, the auditor/consultant should identify potential projects or areas of study for consideration at higher level of assessment.

3.3 Level II – Comprehensive Energy Assessment

The purpose of the Level II – Comprehensive Energy Assessment is to evaluate all energy efficiency measures, both capital projects and

changes to operational procedures, that are available under existing financial constraints. This level of assessment will give a building owner the information that they need to develop a comprehensive energy efficiency program. Any capital intensive projects that require further analysis is to be listed and recommended for Level III.

The data requirements of a Level II assessment are far more rigorous and require more time and significant cooperation from the owner's staff. This requires a detailed examination of electrical and mechanical systems including physical inspection, drawings, building plan including occupancy details, and operation and maintenance programs. The auditor/consultant also undertakes a system performance evaluation of the electrical and mechanical systems based on design performance, such as light levels, ambient air temperature, and humidity, etc. This technical survey of energy using building systems require the use of measurement and testing equipment.

The analysis is far more comprehensive and the resulting report should contain significantly

Level II – Comprehensive Energy Assessment - Specific Activities

- Include all specific activities from lower levels of assessment
- Review mechanical and electrical system design, installed condition, utilization, maintenance and operations
- Review operation and maintenance program
- Measure key operating parameters and compare to design levels
- Detailed breakdown of energy use by end use component (may require computer simulation)
- List all possible EE modifications to equipment and operations
- Prioritize in order of likely implementation
- Estimate potential energy and cost savings
- Estimate implementation cost
- Estimate combined potential energy savings from all EE measures and financial evaluation of implementation
- Meet with owner to discuss priorities based on submission of list of potential EE measures and select practical measures for further analysis
- For each practical measure list:
 - Inefficiencies in current practice
 - Description of EE measure and effect on energy, health, comfort and safety
 - Repairs necessary to optimize the EE measure
 - Impact on occupant service capabilities
 - Impact on operation and maintenance procedures

more detailed and comprehensive information. It should include a comprehensive list of potential energy saving measures, and provide an evaluation of each measure. The auditor/ consultants develops a list of potential projects to be further analyzed based on energy reduction potential, life cycle costing, impact on service level, and impact on peripheral work and programs. Based on the analysis of the potential projects, feasible capital projects for a Level III Assessment are identified.

3.4 Level III - Detailed Analysis of Capital Intensive Measures

The purpose of the Level III – Detailed Analysis of Capital Intensive Measures, also known as an Investment Grade Audit, is to provide the required level of information so that owners have a high level of confidence in making decisions regarding significant capital investment in the identified feasible energy conservation projects. This level of assessment is often associated with energy services or performance contract, and utilizes the services of an ESCO to implement the investigated energy efficiency measures.

The data requirements for a Level III analysis are very specific to the capital intensive measures that are being studied. Further testing and monitoring to verify feasibility may be required.

3.4.1 Technical Analysis

The technical analysis is undertaken specific to the proposed capital intensive measure, and the resulting reports are made very detailed. The preliminary design work for each feasible capital project should be included and detailed information provided in the report or appendices should include equipment lists, schematics and cost estimates. To verify the energy savings modeling of system improvement, including system interactions may be used. A full implementation plan should also be provided.

3.4.2 Financial Analysis

Financial analysis of capital cost and projected savings is provided as background to the recommendations of projects which should be pursued further. A detailed financial [BEE, www.bee-india.nic.in] analysis of each individual project component takes into account the costs on a net present value basis, marginal costs for each unit of savings, simple payback period from the savings, and return on investment. Anticipated adjustments to the baseline compared to the baseline is factored in to the analysis, such as deterioration in annual savings through the life of the project due to the aging of equipment. All costs for engineering, design, materials and operations are considered.

These include:

Level III – Detailed Analysis of Capital Intensive Measures - Specific Activities

- Include all specific activities from lower levels of assessment
- Expand definition of all modifications requiring further analysis listed in Level II
- Perform additional testing and monitoring to determine feasibility
- Perform modeling as required
- Preliminary design of each EE measure
- Estimate energy and cost savings from each measure
- Estimate implementation costs from preliminary design
- Meet with owner to discuss and develop report recommendations
- Detailed financial analysis
- Risk analysis and mitigation plan
- Report (contents specified in section 4.2)

- Contractor and vendor estimates
- Contingency costs
- Construction management fees
- Commissioning costs
- Taxes and duties
- Initial training costs
- Annual service fees including M&V, maintenance and ongoing training

Projects financed by a commercial bank require an analysis of cash flows that includes internal

rate of return, debt service coverage ratio and cash accruals. Use of a sensitivity analysis is recommended to measure the project indicators such as net present value, payback period and internal rate of return with variations in costs of inputs such as electricity, labour and fuel.

3.4.3 Risk Analysis

A risk analysis and mitigation plan [BEE, www.bee-india.nic.in] is also needs to be provided. A matrix using the following variables can be used to assess each of the potential risks:

Table 4: Risk Analysis

The range of risks to be considered (Risk Analysis)	
Design and Construction Risks	<ul style="list-style-type: none"> • Baseline establishment • Technical efficacy • Completion risk • Delay in construction • Conformance to standards
Performance Risk	<ul style="list-style-type: none"> • Equipment performance • Longevity of energy savings • Accuracy of savings estimates • M&V risk • Operational changes • Capacity of facility personnel
Financial, Economic and Regulatory Risk	<ul style="list-style-type: none"> • Cost overrun – initial and operating • Interest rate risk • Foreign exchange risk • Regulatory – changes in laws relating to tax concessions, etc. • Financing • Financial disaster on and other project holders • Credit risk
Market Risk	<ul style="list-style-type: none"> • Energy price risk due to tariff changes for example
Environmental Risk	<ul style="list-style-type: none"> • Insurance coverage in case of an environmental hazard or accident
Legal Risk	<ul style="list-style-type: none"> • New or newly enforced environmental standards
Force Majeure	<ul style="list-style-type: none"> • Natural disaster during the design and construction

- Classification of type of risk
- Reason for risk
- Risk mitigation measure adopted
- Consequences for the lender
- Consequences for the investor

3.5 Reporting Building Energy Assessment Results

The key deliverable at the end of the assessment process is the report drafted by the auditors/consultants. To ensure that his own interests are fulfilled the owner can specify the format the report should be in order to capture relevant building and system related information. Information in tables or spreadsheets is useful in the maintenance of energy data in future, and ease of analysis to identify energy or cost savings measures. (Refer to Appendix G)

The report from a Level I - Preliminary Energy Assessment is based mainly on available documents and on physical inspections. A technical building description should be included, describing the building, major systems, operation and maintenance schedule and other information that may have a bearing on the energy consumption in the facility [BEE, www.bee-india.nic.in]. Information in the building description should include building type, use, construction, age and condition. The building systems described should include lighting, HVAC and water. Energy use and energy indexing should also be included.

A clear graphical presentation and tables of at least two years of annual utilities consumption and cost data should be constructed in a format that permits easy comprehension and simple “apples-to-apples” comparisons with different facilities’ reports. Analysis of the unit cost of electricity/energy the facility is using and other key aspects of the utility rate including time-of-use, demand, power quality, and other charges

affecting utility costs should be included. The report should also include a list of low cost/ no cost measures and preliminary list of future energy efficiency measures to be considered. Any benchmarking data should also reflect this additional information.

In the case of a Level II – Comprehensive Energy Assessment, the report is significantly more detailed and comprehensive than the previous level of assessment. All of the baseline data collected in the previous levels of assessment is augmented with additional data collected over the period of the assessment. The analysis portion of the report is more extensive, providing lists of potential energy efficiency measures and an evaluation of each measure including potential energy savings of this list, the most favorable projects should be further analyzed to verify if there is a need to proceed to Level III analysis for the energy efficiency measure.

The report generated by a Level III – Detailed Analysis of Capital Intensive Measure assessment gives the owner all the information needed to decide to proceed with the studied measures, the amount of financing required and an implantation plan to follow. This should involve at a minimum a preliminary design and costing of each measure, and financial analysis of payback period. Details of design and cost estimation should be included as supplementary to the main body of the report.

Appendix H provides Guideline for Preparation of Energy Audit Report.

The Energy Efficiency Committee should fully review the report before accepting the final draft. If the committee is not satisfied with the report provided at the end of the assessment as it does not adequately addresses the initial agreed upon scope of work, the auditor/ consultant and the Committee should work together to address the situation. Once a satisfactory report has been received, the owner can move forward with the

post-assessment work necessary to implement the energy efficiency measures.

In reviewing the report, the Committee should evaluate to the best of their ability. The report must meet the requirements laid out in the RFP, subsequent contractual agreement or written agreements that have occurred after the signing of the contract. If the committee does

not feel it has the ability to assess the fulfillment of the contractual agreement, it should call upon outside sources for assistance. The following Table 3 indicates areas in which the committee may chose to focus their review of the report, and where they may consider seeking outside assistance.

4. Post-Assessment

4.1 Implementation

An implementation plan is generally included as a part of a Level III assessment, but the building owner can request that an implementation plan be included in any assessment that includes recommended energy efficiency measures. An implementation plan is used to ensure that all involved agencies and personnel know their role and responsibilities throughout the project and to create accountability. It lists activities required to apply the proposed capital and operational improvements, and designates individual responsibilities for each activity. Also the implementation plan should set out time lines and milestones that are to be met, to ensure a timely implementation. The plan can encompass all activities from large scale construction, operational changes, to training and awareness campaigns.

The Energy Efficiency Committee should meet regularly during the implementation phase to discuss and resolve issues resulting during the implementation, and re-evaluate and revise the plan as required. Regular meetings require updates on continuing activities, keeping these activities at the top of mind for those involved and motivation among the staff to continue to meet energy reduction targets.

When implementing energy efficiency measures, low-cost/no-cost measures may be undertaken by building owner themselves or through contract with an outside agency. When low-cost/no-cost measures are undertaken by the building owner, in areas where they have the capability to implement these measures, the full energy savings remain with the owner. If the owner does not feel that there is internal

Table 5: Does My Organization Need an ESCO

Strength/Weakness	If You Answer Yes	If You Answer No
Do you need help in getting internal buy-in into the project?	Consider an ESCO	Consider contracting out the needed services.
Do you need help in identifying and Implementing projects?	Consider an ESCO. By deciding early to use one, you may reduce project implementation costs and speed-up project installation.	Consider contracting out only for the necessary services. Use in-house staff where possible.
Do you lack available and/or experienced staff to install and manage the project?	Consider an ESCO with the expertise to ensure timely project implementation.	Use in-house staff where possible and consider contracting out needed services. An ESCO can be hired for certain services. It may require a stipulated savings amount when their staff and yours work simultaneously.
Do you lack available and experienced staff to maintain the equipment?	Consider an ESCO since it provides these and other services. You can also contract with a maintenance firm.	Use your staff.
Do you lack project financing?	Consider an ESCO to provide financing or to assist you in securing it. ESCOs typically secure financing from third parties such as municipal leasing companies, banks, state, etc.	Use your funds or secure outside funds from municipal leasing companies, banks, state, etc.

capability to implement the measure or adequate financing available to implement the program, ESCOs may be approached to become involved in a performance contract.

4.2 Performance Contracts

It is common that implementation of energy efficiency measures is done as a part of an EE performance contract with the services of an ESCO. In a performance contract, the ESCO is compensated based on the level of energy savings resulting from the project rather than a fixed contract price. Some organizations have the internal capability to implement many of the energy efficiency measures that have been identified in the assessment process, or may not require the financial assistance provided by a performance contract. This allows the organization to retain a larger portion of the energy savings. But if the internal capabilities are not available, the assistance of an ESCO can be valuable in moving EE projects forward.

Two common forms of performance contracts namely ‘guaranteed savings’ and ‘shared savings’ are normally undertaken.

- **Guaranteed Savings:** The building owner takes on the third party financing from a lender, and the ESCO guarantees that the savings will be sufficient to cover the repayment of the loan. If the savings are not adequate to meet the financial requirements of the project, the ESCO pays the difference between the realized savings and project payments. Excess savings may be shared between the ESCO and building owner. Because of the higher risk undertaken by the ESCO in guaranteeing a set level amount of savings the ESCO may negotiate to retain a higher percentage of the savings.
- **Shared Savings:** The ESCO arranges for third party financing of the project. The

savings are shared between the building owner and the ESCO at a negotiated percentage. This removes the risk from the ESCO as the amount of savings to be realized by the building owner is not fixed, but can vary with the realized energy cost savings.

4.2.1 Important Components of a Performance Contract [IFC, 2008]

The performance contract document determines the terms of project operations over the entire contract period. It defines the relationships, roles and responsibilities of each party, and clearly explains the mechanism of project performance and any savings guarantee. This is a long term agreement between the building owner and the ESCO so it must be flexible enough to meet the both parties’ present and future needs. Some of the main components of the performance contract are briefly listed below.

- **Scope of work:** Includes description of services to be delivered related to engineering, design, construction, services, operations and maintenance, and training. It may also include procurement, installation, financing, evaluation, and monitoring of energy savings.
- **Roles and responsibilities of parties:** In the case of a performance contract the operational responsibilities can play a large part in the on-going energy savings. The building owners may also be required to provide drawings, specifications, energy use data and other operating data. The responsibilities of the owner in ensuring operating standards are met can be specified here. The ESCO is responsible to implement all items identified in the scope of work. If either party defaults on their responsibilities, remedies are listed.

- **Terms of agreement:** Terms of the agreement and conditions under which it can be terminated are included.
- **Payment terms:** There are dependent on the type of agreement and financing arrangements selected by the building owner. This can be defined as a percentage of the savings to be retained by each party, and can be for a fixed or variable time period.
- **Ownership of equipment:** The ownership of the equipment during the contract term should be clearly stated, and typically is the property of the party who has arranged for the financing. At the end of the contract the ownership is transferred to the building owner if it is previously the property of the ESCO.
- **Standards of service and comfort:** Required levels for lighting, temperature, humidity and air ventilation should be set for the duration of the contract.
- **Efficiency projects:** All efficiency projects to be implemented by the ESCO should be specified. These projects are usually those indicated in the energy assessment. Method of setting the baseline must be defined, as well as the means to adjust the baseline during the contract period, if necessary.
- **Risk, indemnification and insurance:** The building owner should use this section to protect their staff and building occupants from any damages or liability caused by the ESCO's performance during the contract term. If the contract includes a guarantee of savings, the period and amount of the guarantee should be specified.
- **Project committee:** The members of the Energy Efficiency Committee should be specifically named in the contract to formalize their involvement in the project. Additional members may be added at this time if their expertise is required.
- **M&V:** In performance contracts, measurement and verification plays a critical role as this will determine the level of savings to be attributed to the project. Please refer to section 4.3 for more details on measurement and verification.
- **Training:** Any training requirements for the implementation and ongoing operation of the EE measure must be included, with either the ESCO performing the training or including the cost of external training resources.

4.3 Operation and Maintenance

Operations and maintenance (O&M) effectiveness can be one of the least expensive and most effective ways to reduce energy consumption. By embarking on a comprehensive O&M program designed to reduce energy consumption, building owners can see not only reduced energy costs, but reductions in overall maintenance costs. Traditionally O&M is done on a reactive basis, where maintenance is only provided when equipment or systems fail. A preventative maintenance program that prescribes regularly scheduled checks of equipment helps to improve system performance and extend the useful life. Predictive maintenance programs go a step further in that rather than following a set schedule of maintenance, checks are used to predict when equipment may be in need of maintenance prior to it experiencing any damage. Predictions are based on analysis of known stressors to the system.

O&M should continue as normally scheduled during the assessment process to ensure an accurate assessment of the current conditions and identify areas of improvement. Changes may be required to the existing operation and maintenance program due to potential savings through feasible operational changes or capital projects that have changed operation and

maintenance requirements. The building owner may wish to require updates be made to operation manuals and staff training on the updates be included as a part of the reporting process for Level II or Level III assessments.

Revisions to the operations and maintenance program should be considered throughout the assessment process, both in the initial stages while considering all potential energy savings and while capital-intensive projects are being evaluated. Changes to operation and maintenance procedures and practices should be considered beyond the scope of repair and regular maintenance. Auditors should take a holistic approach, considering how activities undertaken within the building can be used to optimize energy efficiency in existing operations and newly implemented measures.

Activities related to operation and maintenance changes should be included in the implementation plan, designating responsible individuals and time lines. Staff training and awareness programs should be developed to ensure there is full compliance among staff for the new procedures to ensure effective implementation of the energy efficiency program. Operation and maintenance is a continual process and checklists for regular maintenance checks should be developed to ensure compliance. Operations and maintenance records should be summarized and reported back to the Energy Efficiency Committee for their consideration.

4.4 Measurement and Verification

Measurement and verification (M&V) is a critical part of any performance contracts where the ESCO draws payment for their services from the realized energy savings. The building owner should ensure that M&V measures are clearly defined so that they are appropriate to assess the impact of capital and operational projects on energy

consumption and also compare project success with external benchmarks. An internal system of validation of measurements provides continuous feedback to the organization of the success of energy efficiency programs. The organization should also consider verification of results by an external agency for due diligence purposes. It is recommended that the building owner use verification protocols such as those available from such agencies as Efficiency Valuation Organization in their International Performance Measurement and Verification Protocol (IPMVP) [EC Act 2001]. Under IPMVP there are four identified options for M&V:

- **Retrofit isolation:** Savings are determined by field measurement of the energy use of the systems to which efficiency measures were applied separate from the energy use of the rest of the facility. The savings are determined by engineering calculations using short term or continuous measurements taken throughout the post-implementation period.
- **Partially measured retrofit isolation:** This option differs from the regular retrofit isolation method in that savings are determined by field measurements on only some of the energy use parameters of the system (s) to which energy saving measures were applied, rather than on all measures. Partial measurement may be used if the total impact of doing only certain measurements does not introduce significant error into the resulting savings calculation. Careful review of project design and installation ensures that those measures that are monitored fairly represent the probable actual total savings. Measures omitted from M&V should be shown in the M&V plans along with an analysis of the significance of the error their omission may introduce. The savings are determined by engineering calculations using short term or continuous measurements taken throughout the post-implementation period.

- **Whole facility:** Savings are determined by measuring energy use at the whole facility level. Short term or continuous measurements are taken throughout the post-implementation period. The data for the savings calculations are obtained from the analysis of the whole utility energy meter or sub-meter using whatever technique is appropriate, from simple comparison to regression analysis.
- **Calibrated Simulation:** In certain situations, savings may be determined from simulations of the energy use, either of the whole facility or components of it. Simulation routines must be demonstrated to adequately model actual energy performance measured in the facility. The savings are determined by energy use simulation, calibrated with hourly or monthly utility billing data and/or end-use metering.

4.5 Review

Energy efficiency is an ongoing program that does not stop after the completion of the assessment. To make the energy conservation process sustainable, it is important that periodic reviews are made by the Energy Efficiency Committee. These reviews ensure implementation plan is being adhered to, operation and maintenance work procedures are continually reviewed, evaluated and updated, and measurement and verification is being undertaken. The committee can assess ongoing impacts of implemented measures and produce document and showcase the achieved results of the program. By continuing to reassess energy efficiency on an ongoing basis, the committee can identify additional potential measures that may not have been originally considered or that were considered but not implemented in the previous rounds of evaluation.

5. Developing Energy Management Program for an Organization

Energy management programs are essential for reducing energy use in buildings within any organization. The steps involved in developing an energy management program for a facility is depicted in the Fig.1 below.

Within an organization, the management commitment to develop and support an energy management program is most important. Once you have the top management buy-in, that commitment easily percolates down the line.

Step 1: Measure

You cannot manage what you don't measure. This is true in implementing any energy efficiency project. Monitoring has two benefits:

- Monitoring energy use in your facility. This would help in identifying areas of improvement

- Helping in quantifying energy savings from the ECMs that have been implemented. Accurate determination of energy savings gives facility owners and managers valuable feedback on their energy conservation measures (ECMs). This feedback helps them adjust ECM design or operations to improve savings, achieve greater persistence of savings over time, and lower variations in savings (Kats et al. 1997 and 1999, Haberl et al. 1996).

Measurement can be carried out by your own facility team or by an energy audit/Esco firm.

Step 2: Analyze

Once you have the measured data in place, you need to analyze the data by normalizing it. If it is a hospital building, you can normalize the energy consumption data as:

- Annual energy consumption per square meter;

Fig 1: Steps involved in developing energy management program



- Annual energy consumption per bed;

Then one can compare this metric with available benchmarking indices. It is important to compare energy consumption of your building with similar buildings. For example, if your building is air-conditioned, then it is important to compare it with similar buildings which are also air-conditioned. If your hospital is a multi-specialty one, it should be compared with other multi-specialty hospitals.

Step 3: Strategize

Once the benchmarking analysis has been done, it is time to conduct an energy audit to find out potential ECMs. By carrying out a good energy audit, the energy saving potential of different measures can be identified and its cost-effectiveness also needs to be analyzed. The selection of ECMs should be done in such a way that the importance is given to both short term and long term activities.

- **Short Term Activities:** Select the short-term activities that would reduce the demand for electricity, use energy more efficiently, and produce energy savings in shorter time period.
- **Long Term Activities:** There are many long-term activities which could help organizations in saving energy and reducing the costs to operate their facilities. The energy audit should help in identifying them.

Step 4: Implement

ECMs can be implemented by an ESCO or an organizations' own facility team. Implementation

could be retro commissioning, lighting or HVAC retrofit, load reduction or any other measures.

Step 5: Verify

When Organizations invest in energy efficiency, they naturally want to know how much they have saved and how long their savings will last. The determination of energy savings is a challenge, and requires both accurate measurement and use of a repeatable methodology. "International Performance Measurement and Verification Protocol" (IPMVP), is a document which discusses procedures that, when implemented, allow building owners, energy service companies (ESCOs), and financiers of buildings energy efficiency projects to quantify energy conservation measure (ECM) performance and energy savings. Energy savings are determined by comparing energy use associated with a facility, or certain systems within a facility, before and after the Energy Conservation Measure (ECM). The "before" case is called the baseline model. The "after" case is called the post-installation model. Baseline and post-installation models can be constructed using the methods associated with M&V options A, B, C and D.

Step 6: Recognize achievements

After achieving the energy savings through the implementation of an energy efficiency project, it is important to document the achievement. Also, it is a good practice to publish the document so that everyone benefits from that information. Finally, the organization should recognize the achievement of the Energy Management Team or the individual who is responsible for implementing the energy plan and achieving the savings.

APPENDICES

Appendix A: State Designated Agencies

STATE	DESIGNATED AGENCY
Andhra Pradesh	<p>V. C. & Managing Director Non-Conventional Energy Development Cooperation of Andhra Pradesh Ltd. (NEDCAP) 5-8-207/2, Pisgah Complex, Nampally, Hyderabad – 500 001 Phone: 040 – 23 201 172, Fax: 040 – 23 201 666 Email: nedcap@ap.nic.in</p>
Arunachal Pradesh	<p>Director Arunachal Pradesh Energy Development Agency (APEDA), (A State Government Agency) Urja Bhawan, TT Marg, Post Box No. 141, P.O. Itanagar – 791 111, Dist. Papum Pare Arunachal Pradesh Phone: 0360 – 221 1160, Fax: 0360 – 221 4426 Email: apedita@sancharnet.in</p>
Assam	<p>Chief Electrical Inspector-cum-Adviser Government of Assam Pub-Sarania Road, Guwahati – 781 003 (Assam) Phone: 0361 – 252 9611, Fax: 0361 – 252 9611</p>
Bihar	<p>Director Bihar Renewable Energy Development Agency (BREDA) 1st Floor, Sone Bhawan, Birchand Patel Marg, Patna – 800 001 Phone: 0612 – 223 3572, Fax: 0612 – 222 8734</p>
Chhattisgarh	<p>Principal Secretary, Deptt. of Energy, Govt. of Chhattisgarh, Chief Executive Officer Chhattisgarh State Renewable Energy Development (CREDA) Room No. – 283, Dau Kalyan Singh Bhavan, Mantralaya, Raipur – 492 001 (Chhattisgarh) Phone: 0771 – 222 1307/408 0236, Fax: 0771 – 222 1441</p>
Gujarat	<p>Director Gujarat Energy Development Agency (GEDA) 4th floor, Block No. 11 & 12, Udyog Bhavan, Sector-11, Gandhinagar – 382 017, Gujarat Phone: 079 – 23 247 097, Fax: 079 – 23 247 097 Email: director@geda.org.in; info@geda.org.in</p>
Haryana	<p>Director Renewable Energy Department, Haryana S.C.O.No. 48, Sector-26, Madhya Marg, Chandigarh – 160 026 Phone: 0172 – 279 1917/2790 117, Fax: 0172 – 279 1917 Email: hareda@chd.nic.in</p>

Himachal Pradesh	<p>Director (Enf. & EA), O/o Chief Engineer (Comm) Himachal Pradesh State Electricity Board, Vidyut Bhawan, Shimla – 171 004 (HP) Phone: 0177 – 265 5007, Fax: 0177 – 280 3315</p>
Jharkhand	<p>Chief Engineer-cum-Chief Electrical Inspector Energy Department, Government of Jharkhand Ranchi – 834 001 Phone: 0651 – 249 0053, Fax: 0651 – 249 1002</p>
Karnataka	<p>Managing Director Karnataka Renewable Energy Development Limited (KREDL) No. 19, Maj.Gen. A.D. Loganadhan INA Cross, Queen’s Road, Bangalore – 560 052 (Karnataka) Phone: 080 – 22 282 220/22 208 109/22 282 221, Fax: 080 – 22 257 399 Email: kredlnce@yahoo.co.in</p>
Kerala	<p>Energy Management Centre Thycaud P.O., Thiruvananthapuram – 695 014, Kerala. Phone: 0471 – 232 3329/211 5043/232 3363, Fax: 0471 – 232 3342 Email: drbsmdkredl@yahoo.com</p>
Madhya Pradesh	<p>Managing Director M.P.Urja Vikas Nigam Limited (MPUVNL) URJA BHAVAN, Shivaji Nagar, Bhopal – 462 003 (Madhya Pradesh) Phone: 0755 – 255 6526/255 3595/27 6270, Fax: 0755 – 255 3122 Email: drbsmdkredl@yahoo.com;</p>
Maharashtra	<p>Director – General Maharashtra Energy Development Agency (MEDA) MHADA Commercial Complex, 2nd Floor, Opp. Tridal Nagar, Yerwada Pune – 411 006 (Maharashtra) Phone: 020 – 26 614 393, Fax: 020 – 26 615 031 Email: eec@mahaurja.com</p>
Manipur	<p>Chief Engineer (Power) Office of the Chief Engineer (Power), Secretariat: Power Department, Government of Manipur, Manipur – 782 105 Phone: 0385 – 245 0050, Fax: 0385 – 244 9418 Email: ce-power@man.nic.in</p>
Meghalaya	<p>Senior Electrical Inspector Horse Shoe Building, Lower Lachumiere, Shillong – 793 001 (Meghalaya) Email: sei_meg@rediffmail.com</p>

Mizoram	<p>Electrical Inspector Power & Electricity Department, Government of Mizoram Zuangtui, Aizwal – 796 017, Mizoram Phone: 0389 – 235 1170</p>
Nagaland	<p>Chief Electrical Inspector “ Electricity House” Department of Power, Government of Nagaland Kohima – 797 001 (Nagaland) Phone: 0370 – 224 3149, Fax: 0370 – 224 0178</p>
Orissa	<p>E.E. (P) – Cum-DEI(G), (REPO & Projects) EIC, (Elec)-Cum-P.C.E.I, Orissa, Unit-V, Bhubaneswar – 751 001 Phone: 0674 – 239 0418, Fax: 0674 – 239 1255 Email: eicelecypceiorissa@yahoo.co.in</p>
Punjab	<p>Director Punjab Energy Development Agency Solar Passive Complex, Plot No. 1-2, Sector 33-D, Chandigarh (U.T.) – 160 034 Phone: 0172 – 266 3328, Fax: 0172 – 266 2865</p>
Rajasthan	<p>Chairman & Managing Director Rajasthan Renewable Energy Cooperation (A Govt. of Rajasthan Undertaking) E-166, Yudhishtar Marg, C-Scheme, Jaipur – 302 001 (Rajasthan) Phone: 0141 – 222 5859/222 8198/222 1650, Fax: 0141 – 222 6028</p>
Tamil Nadu	<p>Chief Electrical Inspector to Government Electrical Inspectorate Department Government of Tamil Nadu, Thiru Vi.Ka. Industrial Estate, Guindy, Chennai – 600 032 Phone: 044 – 22 500 184/500 227/500 430, Fax: 044 – 22 500 036 Email: ceig@tn.nic.in</p>
Tripura	<p>General Manager (Technical) Tripura State Electricity Ltd. Department of Power, Govt. of Tripura, Tripura, Agartala – 799 001 Phone: 0381 – 232 4933, Fax: 0381 – 231 9427</p>
Uttar Pradesh	<p>Managing Director Uttar Pradesh Power Corporation Limited Shakti Bhawan, 14, Ashok Marg, Lucknow – 226 020, (U.P) Phone: 0522 – 228 7867, Fax: 0522 – 228 8484</p>
Uttaranchal	<p>Chief Project Officer Uttaranchal Renewable Energy Development Agency Energy Park Campus, Industrial Area, Patel Nagar, Dehradun – 248 001 Phone: 0135 – 252 1386/252 138 7, Fax: 0135 – 252 1553 Email: uredahq@gmail.com</p>

West Bengal	<p>Chairman & Managing Director West Bengal State Electricity Board Bidyut Bhawan, 7th Floor, Block-DJ, Sector II, Bidhanagar (Salt Lake), Kolkata – 700 091 (West Bengal) Phone: 033 – 23 598 128, Fax: 033 – 23 598 128</p>
UNION TERRITORIES	DESIGNATED AGENCY
Andaman & Nikobar Islands	<p>Suptdg. Engineer Electricity Department, A&N Administration Vidyut Bhawan, Port Blair – 744 101 Phone: 03192 – 232 404 Email: seelectricity@yahoo.co.in</p>
Chandigarh	<p>Superintending Engineer (Electricity/Electrical) Room No. 523, 5th Floor, Deluxe Building, U. T Sectt. Sector 9-D, Chandigarh – 160 009 Phone: 0172 – 274 0475, Fax: 0172 – 274 0505 Email: seelo@chdut.nic.in</p>
Pondicherry	<p>The Project Director Renewable Energy Agency of Puducherry No. 10, Second Main Road, Elango Nagar, Puducherry – 605 001 Phone: 0413 – 224 4319, Fax: 0413 – 224 4319 Email: reap@pon.nic.in</p>
Lakshadweep	<p>Superintending Engineer (Electrical) Department of Electricity, Union Territory of Lakshadweep Kavaratti – 682 555</p>
NATIONAL CAPITAL TERRITORY	DESIGNATED AGENCY
Delhi	<p>Secretary (Environment) Government of NCT of Delhi Level-6, C-Wing, Delhi Secretariat, I P Estate, New Delhi – 110 002 Phone: 011 – 23 392 108, Fax: 011 – 23 392 029</p> <p>Chief Executive Officer Energy Efficiency And Renewable Energy Management Centre 1st Floor, DFC Building, 37-38 Pankha Road, Institutional Area, D Block, Janakpuri New Delhi – 110 058</p>

Appendix B: Standard Forms for Energy Assessment

Form 1: Standard Building Energy Data Collection Form

Name of the Building:

Primary Data		Year: 2007-08/ 2008-09	
No.	Item	Value	
1.	Year of Building Construction		
2.	Whether your building has received any Green Building Certification? Yes/No		
3.	If yes, specify the rating program		
4.	Connected Load (kW) or Contract Demand (kVA)		
5.	Peak Demand or Maximum Demand Indicated (MDI) (kW)		
6.	Installed capacity: DG/ GG Sets (kVA or kW)		
7.	a. Annual Electricity Consumption, purchased from Utilities (kWh)		
	b. Annual Electricity Consumption, through Diesel Generating (DG)/Gas Generating (GG) Set (s) (kWh)		
	c. Total Annual Electricity Consumption, Utilities + DG/GG Sets (kWh)		
8.	a. Annual Electricity Cost, purchased from Utilities (Rs.)		
	b. Annual Electricity Cost generated through DG/GG Sets (Rs.)		
	c. Total Annual Electricity Cost, Utilities + DG/GG Sets (Rs.)		
9.	Numbers of Floors in the Building		
10.	Area of the building (exclude parking, lawn, roads, etc.)	a. Total Built Up area (sq. ft. or sq.m.)	
		b. Carpet Area (sq. ft. or sq.m.)	
		◦ Conditioned area	
		◦ Non Conditioned area	
11.	Working hours (e.g. day working /24 hour working)		
12.	Working days/week (e.g. 5/6/7 days per week)		
	a. Office	Type of Building (Public sector or Private sector, Industry type e.g. IT, BPO, etc)	
		Total numbers of employees	
		Average numbers of persons at any time in office	
	b. Hotel	Type of Hotel (Star hotel, Motel, Apartment hotel,etc)	
		Numbers of guest rooms	
		Guest overnights in the year (% Occupancy)	
	c. Hospital	Type of Hospital(Multi Specialty, Government, etc)	
		Numbers of patient beds	
		Patient overnights in the year (% Occupancy)	

	d. Schools	Total number of students	
		Total number of staffs	
	e. Shopping Mall	Number of shops	
		Average footfall per day	
13.	Installed capacity of Air Conditioning System	a. Centralized AC Plant (TR)	
		b. Packaged ACs (TR)	
		c. Window/Split ACs (TR)	
		d. Total AC Load (TR)	
14.	Installed lighting load (kW)		
15.	Equipment Load (kW)*		
16.	Water consumption in the building	Water consumption in the year (exclude consumption for garden, lawn, etc.) (kilo liters)	
		Estimated hot water consumption in the year (kilo liters)	
17.	Whether sub-metering of electricity consumption for Air Conditioning, Lighting, Plug Loads, etc. done: Yes/No		
18.	HSD (or any other fuel oil used, specify)/Gas Consumption in DG/GG Sets (liters/cu. meters) in the year		
19.	Fuel (e.g FO, LDO, LPG, NG) consumption for generating steam/water heating in the year (in appropriate units)		
<i>*In many cases, this can be gathered from the UPS system.</i>			

Form 2: Summary of Connected load /Equipment Inventory

Sr. No	Details of Connected Load	Nos.	Watts/Unit	Total kW	Operating Hrs
I	Indoor lighting				
	Fluorescent Lamps				
	Incandescent Bulb				
	CFL				
	Halogen				
	Any other				
II	Compound lighting				
	HPMV				
	Metal Halide				
	Flood lights				
	Sodium vapor				
	Any other				
III	Ventilation systems				
	Ceiling Fans				
	wall mounted Fans				
	Air circulators				
	Pedestal fans				
	Desert Cooler				
	Room cleaners/Air purifiers				
	Exhaust fans				
	Window A.C.				
	Blowers				
	Kitchen ventilation-Canteen				
	Kitchen ventilation-officer lounge				
IV	Air conditioning				
i)	Localized AC systems				
	Window AC				
	Split A.C.				
	Precision AC units				
	Package units				
ii)	Central AC system				
	Chiller package				
	Condenser pump				
	Chilled water pump				

	Cooling Tower				
	Air Handling Unit				
V	Office equipment				
	LAN Switches				
	Computers				
	Servers				
	Printers				
	Photocopier machines				
	Fax machines				
	Telephone exchange				
VI	Lifts				
	Passenger lifts				
	Bullion lifts				
VII	Pumps				
	Water Pumps				
	Hydro pneumatic pumps				
	Sewage pumps				
VIII	Power loads				
	Shredding/Briquetting machines				
	CVPS machines				
	Heater/Hot case				
	Kitchen power - Canteen				
	Kitchen power –officers lounge				
IX	Uninterrupted/ stabilized power systems				
	UPS				
	Invertors				
	Voltage stabilizers				

Form 3: Primary Building Type

Office

- Owner Occupied
- Leased (1-5 Tenants)
- Leased (5+ Tenants)
- Other—Define

Hotel/Motel

- Motel (No Food)
- Hotel
- Hotel/Convention
- Other—Define

Apartment

- General Occupancy
- Gated Community
- Other—Define

Education

- Primary
- Secondary
- University
- Other—Define

Food Services

- Restaurant - Full Service
- Fast Food
- Lounge
- Other—Define

Health Care

- Nursing Home
- Clinic
- Outdoor Patient Department
- Full Service Hospital
- Other—Define

Retail

- Supermarket
- General Merchandise
- Shopping Mall W/O Tenant Loads
- Shopping Mall Without Tenant Lighting Loads
- Shopping Mall
- Specialty Shops
- Other—Define

Assembly

- Theatre
- Museum/Gallery
- Temple/Mosque/Church
- Arena/Gym
- Other—Define

Other

- Laboratory
- Warehouse
- Warehouse—Refrigerated
- Recreation/Athletic Facility
- Jail
- Transport Terminal
- Multi-Use. Complex
- Other—Define

Appendix C: Guidelines on Preliminary Energy Use and Walk -Through Analysis – The eeBuildings Approach

The US Environmental Protection Agency’s “eeBuildings” program works with building partners to facilitate quick and cost-effective initial energy performance baseline development and identify low- and no-cost energy performance improvements [US Environmental Protection Agency, www.epa.gov]. The eeBuildings program model based on the US ENERGY STAR model outlines a packaged approach that is consistent with the required steps prescribed under the Pre-Assessment stage in this guide including:

- Gaining a full understanding of how energy is being consumed and the associated costs.
- Identifying no/low cost measures for energy reduction.

Results from this approach will also help owners report on relevant “energy conservation measures”.

The eeBuildings approach works on the principle that the fastest, least-costly, and most significant reductions in energy use can be achieved through improved management of building systems operations, using best practice techniques and the existing digital control system. This framework may be a good initial approach for buildings to use in setting a baseline and evaluating a range of energy conservation measures.

Below are guidelines from the eeBuildings turn-key approach that a building owner may wish to use during the “Preliminary Energy Use and Walk Through Analysis” stage prescribed under the Pre-Assessment phase in the guide.

Step 1 - Collect, Display, and Analyse Energy Consumption and Cost Data Using the Energy Performance Monitoring Tool

Routine collection and analysis of energy usage and cost data is essential to improving building

energy performance. It assists with early detection and faster resolution of performance problems including avoiding peak tariffs and reducing utility costs, which prevents unnecessary spending and tenant discomfort. Finally, data collection allows you to communicate your success to building owners, tenants, and potential new tenants.

The eeBuildings Energy Performance Monitoring Tool (EMPT) is a free Microsoft Excel-based tool that can automatically generate tables and graphs to help you track and analyze monthly and annual energy performance. It is designed for easy data input, since it relies solely on regular monthly electric utility bills for key data inputs. Once utility bill data is entered, you can automatically generate a number of charts and graphs that describe your building’s energy use and costs over time. You can also easily choose to run tailored comparisons of specific time periods, to assess changes in energy use over time. See contact information at the end of this section for obtaining a free copy of the EPMT (*).

Using the tool is very easy:

1. The first time you use the tool, you will enter building information, including:

- Building name
- Total construction area (square meters)
- Total conditioned area (square meters)

2. Each month, you enter basic information from your utility bill, including multiple meters similar to Figure #1:

- Unit tariffs for each rate category (e.g., peak, valley, and mid)
- Actual peak demand (kW)
- Contracted peak demand (kW)
- Total electricity consumption (kWh)

- Total cost for consumption
- Descriptions of circumstances that might impact monthly demand or consumption.

3. The tool also generates graphical displays of the data you enter:

- Monthly electricity consumption and cost versus a baseline. (Displays up to 12 months of data, and you select the start-dates and end-dates for the graph.)
- Annual electricity consumption compared to the previous year.
- Actual peak demand versus contracted demand.

Step 2 – Identify No And Low-Cost Opportunities Through a Walk Through Analysis of Building Facilities

Case studies in India, China, and the US demonstrate that savings of 10% to 25% in energy use are possible using no-cost and low-cost measures to improve building management, without impacting key operations or tenant comfort.

Through the use of a simple walk through analysis (as prescribed in the Pre-Assessment phase of this guide), eeBuildings provides building managers a means of identifying a range of specific no-cost and low-cost opportunities for minimizing energy costs with minimal expenditure by the building owner. Several common opportunities this assessment focuses on are listed below:

- **Promote tenant awareness:** Strategies for informing tenants of the simple ways they can contribute to the property management team’s energy reduction efforts can be very effective. Where tenants pay for energy as they use it, which is usually the case, they are motivated to participate in schemes to reduce energy consumption. Since tenants often independently operate climate and lighting controls within tenant space such outreach can be very effective in reducing energy consumption.

- **Clean Heating and Cooling Coils and Filters:** Dirt and dust on HVAC coils and filters significantly reduces heat transfer and airflow necessary for building conditioning. Removing this dust and dirt from heating and cooling coils and filters increases effective system efficiency, but is often overlooked or not approached aggressively enough in regular maintenance procedures.

- **Clean and Repair Outside Air Dampers and Bird Screens:** It is very common to find critical dampers and associated bird screens that are not performing due to dirt and debris or mechanical issues, which affects proper airflow.

- **Carefully Control Operating Schedules:** Equipment such as fans, pumps, chillers, and lights are often operated on schedules that do not correspond to occupancy schedules, resulting in more energy use in buildings than necessary. Schedules can be developed for operating lights and equipment that match occupant need, and staff can be trained to turn lights and equipment on and off. In some buildings, the electronic building control system can be harnessed to control key building systems automatically.

- **Use “Free Cooling” or Economisation:** Most commercial office buildings require cooling even during mild and cold weather conditions because of internal heat sources (e.g., people, computers, lights). A cooling system with an economizer can use outdoor air that is below the interior temperature set point to satisfy all or part of this cooling demand.

- **Operate Building at Slightly Positive Pressure:** Operating a building at a net negative pressure causes unconditioned, unfiltered outside air to enter the building via entrances, windows, and other openings, decreasing comfort and increasing energy use as this unwanted outside air is conditioned.

Opportunities identified in this stage can be incorporated in Appendix E – “Guideline on Energy Conservation Measure (ECM)”. Opportunities identified in this stage will also play a crucial role in the “Post Assessment – Operations and Maintenance” section prescribed by the Standard Business Design Guide.

Step 3 – Implement Measures and Use the EPMT to Monitor Performance Improvement Over Time

As more aggressive measures are being considered using a more detailed assessment of the building, begin to carefully monitor utility bills to understand how no cost and low cost measures are impacting energy performance. This continuous monitoring

of performance will improve the understanding of any measure deployed in the building.

(*) To obtain a free copy of the eeBuildings Energy Performance Monitoring Tool (EPMT), please email your request to: eeBuildings@epa.gov

Appendix D: Annual Cooling Degree Hour and Day for Select Cities [US Department of Energy, www.eere.energy.gov]

Annual cooling degree hour and day of different Indian Cities

Cities	Annual Cooling Degree Hour (23°C baseline)	Annual Cooling Degree Hour (27°C baseline)	Annual Cooling Degree Day (18°C baseline)
Agartala	27266	10119	2591
Ahmadabad	44605	24353	3435
Akola	43307	23984	3382
Aurangabad Chikalth	30961	15431	2707
Balasore	35625	15473	3170
Bangalore	15090	4979	2121
Belgaum/Sambra	16806	6824	2202
Bhopal/Bairagarh	32499	16984	2707
Bhubaneswar	37257	16438	3343
Bhuj-Rudramata	42239	22446	3318
Bikaner	49972	31837	3360
Bombay/Santacruz	37791	15252	3360
Calcutta/Dum Dum	35592	15909	3056
Chitradurga	21617	8536	2573
Coimbatore/Peelamed	27917	11373	3091
Cuddalore	43696	19732	3698
Cwc Vishakhapatnam	37806	14113	3379
Gadag	24229	10454	2702
Gauhati	23669	8529	2344
Goa/Panjim	34409	12313	3334
Gwalior	41219	24246	2969
Hissar	42773	26406	3064
Hyderabad Airport	35148	17066	3095
Indore	29780	15199	2576
Jabalpur	33491	17628	2747
Jagdapur	26071	11676	2543
Jaipur/Sanganer	39235	22276	2918
Jamshedpur	36663	17968	3077
Jodhpur	47234	28226	3366
Kakinada	43582	19920	3701
Kozhikode	37758	13820	3458
Kurnool	47561	25511	3779
Lucknow/Amausi	35728	19267	2756
Machilipatnam	42941	19714	3658

Madras/ Minambakkam	44343	20813	3802
Mangalore/BajPe	32381	11802	3304
Nagpur Sonegaon	40125	22073	3221
Nellore	50148	26149	4047
New Delhi/Palam	42516	25343	3011
New Delhi/Safdarjun	37217	21187	2762
Patiala	30399	16307	2356
Patna	35984	18438	2843
Pbo Anantapur	45026	23136	3637
Poona	22919	10154	2298
Rajkot	41435	21422	3410
Ratnagiri	31322	10458	3128
Sholapur	40549	20758	3461
Surat	39941	17891	3418
Thiruvananthapuram	34177	11796	3374
Tiruchchirapalli	48987	25169	3984
Veraval	34717	13398	3199

Appendix E: Model Response to RFP Outline for Commissioning Building Energy Assessment [LBNL,2006]

Background/Introduction

Describe the motivation or the driver that requires the “Organization” to conduct these audits. Include information about your organization, the facilities/buildings that need to be audited. Briefly describe the type of expertise that the organization will be looking at before awarding audit contracts. Include any other topics that may be relevant to conducting the building energy audit. Use Appendix A to provide basic information about the building

Minimum Qualifications

Individuals and firms must meet the minimum qualifications before they will be considered for the award of any building energy assessment contracts [Canmet Energy Technology Centre, www.cetc-vareness.nrcan.gc.ca]

- Level I Energy Auditor Minimum Qualifications
- Level II Energy Auditor Minimum Qualifications
- Level III Energy Auditor Minimum Qualifications

1. Proposal Content: Carefully read all the terms and conditions contained in this RFP and follow the instructions given. Describe qualifications, experience and capability to do the work described in this RFP, and address all information requested below for purposes of scoring under all the information requested may be rejected as non-responsive.

The entire original proposal shall be typewritten, single-sided on standard (A4) paper. The proposal shall be a maximum of 10 pages, excluding resumes and work samples, as noted below.

The original signed proposal, plus three (3) legible copies of the complete proposal

must be submitted. Proposers must provide three copies of all work samples, resumes, and other required attachments.

- Proposals must contain the following information:

2. Cover Letter/Title Page: Proposals may include one or both of these pages and should contain all the key information about the proposal. These pages are not included in the 10-page limit.

3. Narrative:

- Indicate the level or type of work, or both, you or your firm is proposing to perform under this solicitation.
- Indicate the technical services you or your firm specializes in.
- Project Experience: Describe prior work performed during the last 3 years that is similar to the work being proposed (building energy audits and energy efficiency project experience should be given priority) under this solicitation. Provide a brief description of each project.
- Personnel Experience/Qualifications: Submit names and relevant experience (be as specific as possible and include any training workshop attended or certifications received for building energy audits) of the personnel, including subcontractors, who will perform the work being proposed under this RFP.
- Organization, Management, and Administration. Describe how the work will be organized, managed, and administered so as to meet specified requirements.
- Work Samples: Provide samples of typical written and graphic materials prepared for the type of work being proposed under this RFP.

4. Forms: Proposers must complete and submit the following forms with the proposal, which

are included with the RFP. These forms are not included in the 10-page limit on proposal length.

Appendix B: Experience: Complete a separate form for each person.

Appendix D: Certification, Software, and Equipment: Provide the requested software and equipment information as it applies to the firm, not individuals.

Appendix E: Complete the firm's ability to provide audit services in different districts/regions of Maharashtra.

5. Cost Proposal : Identify hourly/daily rates for all personnel, including subcontractors, who would perform the work specified in the proposal if it is a "time and materials" contract.

In addition to hourly rates, provide a per-square-meter rate for energy assessments (Level I, II and/or III) of conditioned space if it is a "fixed price" contract. The per-square-meter fee shall include all costs and all activities except travel.

1. Evaluation Criteria: The evaluation process will be based on the following criteria. To be listed as a qualified auditor, a firm or individual must demonstrate its ability to conduct work as specified in the proposal based on the criteria specified in A - F.

- a. Technical Service Specialties:** Knowledge and expertise of the firm or individual in performing the work specified in the proposal. Specifically, conducting on-site energy audits of public buildings and facilities. This includes all Facilities and Equipment/Systems identified herein.
- b. Project Experience:** Extent of experience in performing the type of work described in this RFP.
- c. Qualifications and Experience of Personnel:** Level of qualifications and expertise of personnel who will be assigned to the contract that demonstrates the ability to perform the type of work described in this RFP.

d. Organization, Management, and Administration: Level of skills and experience in organizing, managing and administering projects. This involves report preparation in a timely and efficient manner and the ability to meet project budgets and timelines. It also includes good communication skills with an emphasis on clear and simple presentation of ideas, and an ability to work with people.

e. Work Samples: Work samples demonstrate and support the required level of experience and expertise for the work being proposed.

f. Proposal: The proposal is complete, including all required information, completed forms and work samples. Proposal content is accurate, grammatically correct, clear and concise.

All proposers will be notified of the results of their evaluation.

2. RFP Terms and Conditions: Cost of developing the proposal, attendance at an interview or any other such costs are entirely the responsibility of the proposer, and shall not be reimbursed in any manner by the Organization.

The Organization reserves the right to issue amendments to this RFP prior to the closing date. In the event it becomes necessary to amend any part of this RFP, the Organization will provide notice of the amendment in the same manner as notice of the original RFP. If amendments to the RFP are issued, each proposer must acknowledge receipt of each specific amendment in the transmittal letter accompanying proposals. If a proposer does not acknowledge receipt of any amendment, then that proposer may be deemed non-responsive.

The Organization reserves the right to reject any or all proposals, if such rejection would be in the public interest. The Organization reserves the right to cancel or postpone this solicitation at any time, if such action would

be in the public interest. The Organization reserves the right to award no Agreements to Agree, or to award multiple Agreements to Agree. Likewise, the Organization reserves the right to negotiate the statements of work from within the scope of work described in the RFP that may be required under Work Assignment Contracts with a specific contractor.

Firms or individuals submitting proposals in response to this RFP may be requested by the Organization to answer questions or provide additional documentation. This will allow the proposer to clarify the proposal and answer questions the Organization may have regarding proposer's understanding of the scope of work identified herein, and the other Contracting Agencies to be served. However, the Organization may determine to make an award without further discussion of proposals received. Therefore, it is important that each proposal submitted be as complete, clear and concise as possible.

3. Schedule: Interested firms and individuals will have an opportunity to qualify for the work

described in this RFP. The Organization plans to evaluate proposals and announce the winner according to the following schedule (dates are for illustrative purposes):

- **RFP Published:** June 1, 2006
- **Deadline for Proposals:** July 15, 2006 (Will depend on specific circumstances but try to give 4-6 weeks if possible for response)
- **Evaluation Period:** September 1, 2006 (Will depend on specific circumstances but try to give 2-4 weeks if possible for response)
- **Winner Announcement:** September 15, 2006

4. Point of Contact

5. List two point of contacts: One technical and one administrative in appendix 1. The building energy auditor will need to work through them when requesting information or when they have questions.

Appendix F: Guidelines to System Level Data Collection & Analysis

	Data collection:	Analysis
Energy Bill Analysis	Last two year energy bills, Peak load on daily basis for last 2 years, Occupancy data, weather data. Maximum demand, KW, PF, KVAR, etc	Kwh/day, Kwh/Week, Kwh/Month/Year Energy consumption breakup by services in the building, variables affecting energy consumption
Electrical supply (transformer) and distribution system	Inventory of all connected loads including capacitors with specifications Peak load on daily basis for last 2 years, Single line diagram of the electrical supply and distribution. 24 hours monitoring of building load trends voltage, KW, KWh, etc, PF, Ampere with 10 minutes interval, Feeder wise loading at substation KW, Power factor, Ampere	Energy consumption pattern (month wise) Peak load pattern for the year. Connected load distribution. Energy end use pattern. Transformer rationalization Power factor pattern for the year
Lighting system	Inventory of lighting fixtures floor wise – number and type of fixtures Lux measurement –room wise or zone, Power consumption measurement of light (for each type of fitting) fixture, Hours of operation, Floor plan	Calculation of zone wise lux Lighting power consumption in terms of KW/fixture and KW/Sq. meter
Window/ split AC's localized system	Inventory of Air conditioners (type, number and age), Sample size selection and testing for power consumption and capacity (TR), KW, Air flow, inside air temp & humidity, ambient air temp. & humidity), hours of operation, Air conditioned floor area	Calculation of zone wise tons/sq.mtr IKW/TR of individual AC unit
Central Air conditioning system a) Chiller package b) Chilled water pumps	Inventory of chiller packages (make, type, ratings, number and age), pumps to record type, rating, and operating hours of individual pumps. Power consumption and capacity (TR) KW, Power factor, water flow rate, inside air temp & humidity, ambient air temp. & humidity), Hours of operation, A/C floor area, Pump discharge flow, Suction head, Discharge head, Operating hour, Study of water distribution pipeline network for calculating the pressure drop across the pipeline.	Heat transfer in condenser and chiller IKW/TR of chiller package, Loading pattern of chiller packages, Actual power consumption, System efficiency Pump efficiency, Motor efficiency, Piping pressure drop estimation

<p>Condenser water pumps</p>	<p>Inventory of pumps to record type, rating, and operating hours of individual pumps. Pump discharge flow, Suction head, Discharge head, water distribution pipeline network for calculating the pressure drop across the pipeline.</p>	<p>Actual power consumption, System efficiency, Pump efficiency, Motor efficiency, Piping pressure drop estimation</p>
<p>Cooling towers</p>	<p>Inventory of cooling towers make, model, type, rating and operating hours of individual tower. Water & Air flow rate, Hot & Cold water temperature (Inlet/outlet water temp), Ambient dry and wet bulb temperature</p>	<p>Heat rejection capacity, Tower approach Delta T, Power consumption</p>
<p>Air handling units/ Fan coil units</p>	<p>Inventory of AHU's make, model, type, rating and operating hours of individual AHU. Chilled water flow rate. IN/OUT water temperature, Air delivery CFM, Return air temperature Delivery air temperature, Pressure drop across the cooling coil, Power consumption KW, power factor, shaft RPM, Fresh air intake</p>	<p>Heat transfer capacity. Loading of the motor and load factor Power consumption Temperature profile and RH of the conditioned space</p>
<p>Diesel generator sets</p>	<p>Technical specification, rating and operating hours of individual DG set.</p>	<p>Loading pattern of the DG sets Specific energy consumption – (KWh/Litres)</p>
<p>Water pumping systems</p>	<p>Pumps type, rating, and operating hours of individual pumps. Pump discharge flow Suction head, Discharge head, Operating hour,</p>	<p>Actual power consumption, System efficiency, Pump efficiency, Motor efficiency, Piping pressure drop estimation</p>
<p>Motors and other drives (Shredding Briquetting/CVPS system)</p>	<p>Inventory of motors/drives rating, operating hours. Voltage, frequency, line current, power factor, power drawn and the shaft RPM at the operating conditions.</p>	<p>Loading of the motors and load factor Power factor, Power consumption, Drive efficiency</p>
<p>Uninterrupted Power Supply (UPS)</p>	<p>Technical spec., Connected Load on the UPS</p>	<p>Loading and Efficiency of the UPS</p>

Appendix G: Guidelines on Energy Conservation Measures (ECMs)

1. Full written description of each ECM to include:

- Existing conditions and data collection approach (snapshot, short-term, or long-term measurement of data.)
- Recommendations. Include discussion of facility operations and maintenance procedures that will be affected by ECM installation and implementation

2. Baseline energy use:

- Summary of all utility bills
- Base year consumption and description of how established

3. Savings calculations:

- Base year energy use and cost
- Post-retrofit energy use and cost
- Savings estimates including analysis methodology, supporting calculations and assumptions used
- Operation and maintenance savings, including detailed calculations and description
- If manual calculations are employed, formulas, assumptions and key data shall be stated
- Cost estimate -- detailed scope of the construction work needed, suitable for cost estimating including:
 - Engineering/design costs
 - Contractor/vendor estimates for labor,

materials, equipment; include special provisions, overtime, etc., as needed to accomplish the work with minimum disruption to the operations of the facilities.

- Construction management fees
- Commissioning costs
- Other costs/fees
- Environmental costs or benefits (disposal, avoided emissions, handling of hazardous materials, etc.)
- Others if any

The Consultant should consider the following while analyzing potential energy and water saving measures.

- Comfort and maintenance problems
- Energy use, loads, proper sizing, efficiencies and hours of operation
- Current operating condition
- Remaining useful life
- Feasibility of system replacement
- Hazardous materials and other environmental concerns
- Customer's future plans for equipment replacement or building renovations
- Facility operation and maintenance procedures that could be affected.
- Critical system backups

Appendix H: Guidelines for Preparation of Energy Audit Report

Structure of the Energy Audit Report

Each report should include:

1. Title Page

- Report title
- Client name (company for which facility has been audited)
- Location of the facility
- Date of Report
- Audit contractor name

2. Table of Contents

3. Executive Summary

All information in the Executive Summary should be drawn from the more detailed information in the full report. The Executive Summary should contain a brief description of the audit including:

- Name, plant (s), location (s) and industry of the company audited
- Scope of the audit
- Date the audit took place
- Summary of baseline energy consumption presented in table form. Baseline energy consumption refers to the energy used annually by the facility/system audited.
- Results:

- Assessment of energy- consuming systems
- Identification of EMOs and the estimated energy, greenhouse gas (GHG), and cost savings associated with each option along with the related cost of implementing the measures and the expected payback period. This material should be presented in table form. In the event that an audit covers more than one facility, the statistics for each facility should be reported on an individual basis to the extent possible.
- Recommendations summarized in table form.

4. Introduction; The Introduction should include:

- Audit Objectives: a clear statement that defines the scope of the energy audit in clear and measurable terms - example, space (s), systems and/or process (es) to be audited
- Background Information: a description of the location of the facility where the audit will be conducted, as well as information regarding facility layout, products/services produced/ distributed, operating hours including seasonal variations, number of employees and relevant results of previous energy initiatives.

5. Audit Activity and Results: This section should make reference to:

- Description of the audit methodology (techniques - e.g inspection, measurements, calculations, analyses and assumptions)

Recommendations							
Rec. #	Description	Potential Electricity Savings (kWh/yr)	Potential Natural Gas Savings (m ³ /Yr)	Other potential energy savings (specify type and units)	Potential savings (Rs./yr.)	Cost to implement (Rs.)	Simple Payback (Yrs.)

- Observations on the general condition of the facility and equipment
 - Identification/verification of an energy consumption baseline in terms of energy types, units, costs and greenhouse gas (GHG) emissions for the facility/system being assessed
 - Results of the audit including identification of EMOs and the estimated energy, GHG, and cost savings associated with each measure as well as the required investment and payback period associated with each of the EMOs identified.
- 6. Recommendations:** This section should list and describe the recommendations that flow from the identification of EMOs and may include details concerning implementation. An explanation should be provided for recommending or not recommending each EMO identified in the results.
- 7. Appendices:** Appendices include background material that is essential for understanding the calculations and recommendations and may include:
- Facility layout diagrams
 - Process diagrams
 - Reference graphs used in calculations, such as motor efficiency curves
 - Data sets that are large enough to clutter the text of the report.
- **Documentation:** All numbers related to the results should be supported by information indicating how they were derived. This includes all savings, investment and payback information.
 - **Mathematical Accuracy:** All calculations should be checked for mathematical accuracy. Where, for example, a table showing the breakdown and total of energy use or costs is included in the report, the total of the numbers in the breakdown should equal the amount shown as the total. If, for some reason, this is not the case, there should be a note explaining why the discrepancy is appropriate. Similarly, if numbers used in the full report differ from corresponding numbers shown in the Executive Summary, the report should contain a note or notes explaining why the discrepancy is appropriate.
 - **Logical Consistency:** The results should be logically consistent. For example, separate summaries in the report may use different bases for calculating energy savings. One summary might be based on energy savings related to the recommended measures while a second summary might be based on energy savings related to both recommended and non-recommended measures. If such a logical inconsistency is considered necessary by the auditor, it should be explained in a note and in the example above, both tables should be referenced to the note.
 - **Illustrations:** Graphs and charts may be used to spark interest in the report and implementation of the recommendations but should not be used as a substitute for numerical data.

General Points on Report Writing

- **Grammar and Style:** The report should be grammatically correct. The language should be clear, concise and understandable by all readers. The writer should avoid jargon.

Table for the Executive Summary

Baseline Energy Use and Cost						
Audited Facility/ System Description	Electricity		Natural Gas		Others (Specify)	
	Units (kWh/ yr)	Cost (Rs.)	Units (m ³ /Yr)	Cost (Rs.)	Units	Cost (Rs.)

Appendix I: References

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