Guidelines GB 4.0 – Energy Auditing for Existing Facilities

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info@pcfc.ae P.O. Box 2001, Dubai, U.A.E. | ص.ب. 2001 دبي، الإمارات العربية المتحدة Call Center مركز الاتصال 800 990
@pcfc_dubai | www.pcfc.ae

Introduction

The Green Building Department of the Environment, Health and Safety- Trakhees as a competent authority and regulatory arm of Dubai World Business Units under the Ports, Customs and Free Zone Corporation (PCFC) for all Green Building activities is providing the above guideline for the purpose of assisting the stakeholders in their energy efficiency initiative.

Scope

This general guideline is applicable to all the existing buildings / facilities within Dubai World business units under the Ports, Customs and Free Zone Corporation (PCFC). This is also applicable to the energy assessors and consultants working on the green building projects within the jurisdiction who would potentially offer energy auditing services for the clients.

Aim

This document provides an understanding of “Audit “as related to the buildings and its systems. This also provides an insight into the purpose, types and methodology of the audit that is generally carried out on building facilities and the benefits that are likely to be accrued. This guideline is intended to provide the facility owners and the operators the information required to appreciate the role of auditing on the operational efficiency of the facility and to take an informed decision on the nature and extent of auditing required for their facilities.

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Background

Buildings consume significant amount of the annual energy consumption and accordingly gains prominence in the context of energy conservation. It has also been universally recognized that improving the performance of the existing Buildings hold the key for the sustainability of the environment considering the potential it offers for conserving precious resources mainly water and power. It is in this context that Auditing is perceived as a credible and definitive approach to study the building systems the saving potential.

Definition

The term audit is commonly used to describe a broad spectrum of studies ranging from a quick walk-through of a facility to identify major problem areas to a comprehensive analysis of the implications of alternative resource efficiency measures sufficient to satisfy the financial criteria of sophisticated investors. The scope of such an exercise may include besides energy and water several other parameters such as waste generation, recycle contents, carbon foot print etc that are relevant to the organization.

The “Energy Audit” serves to identify all of the energy streams into a facility and to quantify energy use according to discrete functions. By detailing where and how resources are used in the facility,

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An audit can equip the client with the knowledge to lower operating costs, and provide a roadmap for improvements tailored to their specific facility. It's a powerful tool to help existing buildings meet – and even exceed – their energy and water goals. Often conducted by an outside independent source, an audit provides a comprehensive picture of how energy is utilized, conserved, and potentially lost in the building. Energy Audit can be considered an essential tool of energy management.

The term "ENERGY AUDIT" as used in this document would generally refer to all the sources of energy in the facility.

Purpose

The purpose of Energy Audit in a facility is to address the following areas

1) Identify ALL /relevant energy systems
2) Evaluate the condition of the systems
3) Analyze the impact of improvements on those systems
4) Prepare a detailed Energy Audit report

And it involves asking and answering series of questions as under:

1) What type of energy is being used?
2) How much energy is being used?
3) What is the consumption pattern?

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4) How much does it cost?

5) What are the areas of priority?

Benefits

While there are numerous benefits in subjecting an existing facility to an Audit, the important ones can be highlighted as under

1) Identify Energy use among the various services
2) Identify opportunities for energy conservation specific to the organization / facility
3) Establishing an energy management program based on the valuable data generated by Auditing
4) Maintain an efficient balance between a building's annual functional energy requirements and its annual actual energy consumption.
5) Reduce wastage of resources
6) Reduction in carbon footprint.
7) Reduce wastage of money in operations by achieving operational efficiency.
8) Demonstrating the commitment to the environment by conserving the resources
9) Demonstrating CSR.
10) Establishing a benchmark for the organization and a provision for comparing with PEER groups.

Energy Audit – Types

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Energy auditing is generally carried out in several parts of the world and accordingly there are several standards and terminologies that are used although the ultimate goal of all the approaches is to improve the efficiency and save resources. Notwithstanding the fact that the paths and milestones prescribed by these standards present minor variations in terms of approaches, they all lead to the same destination.

The Audit programs in general terms, fall into 3 broad categories although they can be further broken down into several fundamental elements or sub categories. These would be dependent on the Auditor when it comes to actual tasks performed and the level of effort dispensed within these categories. Hence it is crucial that the owner of the facility spells out the exact requirements in the detailed scope of works as this is the only way to ensure that the proposed audit will meet the specific needs of the organization/facility.

Preliminary Audit

The preliminary audit alternatively called a simple audit, screening audit or walk-through audit, is the simplest and quickest type of audit. It involves minimal interviews with site operating personnel, a brief review of facility utility bills and other operating data, and a walk-through of the facility to become familiar with the building operation and identify glaring areas of energy waste or inefficiency.

Typically, only major problem areas will be uncovered during this type of audit. Corrective measures are briefly described, and quick estimates of implementation cost, potential operating cost savings, and simple payback periods are provided. This level of detail, while not sufficient for reaching a final

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decision on implementing proposed measures, is adequate to prioritize energy efficiency projects and determine the need for a more detailed audit. Through this audit it is possible to set the path for a focused approach thereby eliminating wasted efforts. It would also provide a preliminary assessment of the overall performance or the health of the facility.

General Audit

The general audit alternatively called a mini-audit, site energy audit or complete site energy audit expands on the preliminary audit described above by collecting more detailed information about facility operation and performing a more detailed evaluation of energy conservation measures identified. Utility bills are collected for a 12 to 36 month period to allow the auditor to evaluate the facility's energy/demand rate structures, and energy usage profiles. Additional metering of specific energy-consuming systems is often performed to supplement utility data. In-depth interviews with facility operating personnel are conducted to provide a better understanding of major energy consuming systems as well as insight into variations in daily and annual energy consumption and demand.

This type of audit will be able to identify all energy conservation measures appropriate for the facility given its operating parameters. A detailed financial analysis is performed for each measure based on detailed implementation cost estimates; site-specific operating cost savings, and the customer's investment criteria. Sufficient detail is provided to justify project implementation.

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Investment-Grade Audit

In most corporate settings, upgrades to a facility's energy infrastructure must compete with non energy related investments for capital funding. Both energy and non-energy investments are rated on a single set of financial criteria that generally stress the expected return on investment (ROI).

The projected operating savings from the implementation of energy projects must be developed such that they provide a high level of confidence. In fact, investors often demand guaranteed savings.

The investment-grader audit alternatively called a comprehensive audit, detailed audit, maxi audit, or technical analysis audit, expands on the general audit described above by providing a dynamic model of energy use characteristics of both the existing facility and all energy conservation measures identified. The building model is calibrated against actual utility data to provide a realistic baseline against which to compute operating savings for proposed measures. Extensive attention is given to understanding not only the operating characteristics of all energy consuming systems, but also situations that cause load profile variations on both an annual and daily basis. Existing utility data is supplemented with sub metering of major energy consuming systems and monitoring of system operating characteristics.

Energy Audit Methodology –Brief

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A full-fledged Energy Audit exercise despite the fact that it is carried out in several formats adopting different strategies, would primarily include the following stages:

1. Interview with Key Facility Personnel
2. Tour of the facility proposed to be audited.
3. Document Review
4. Facility Inspection
5. Staff Interviews
6. Utility Analysis
7. Identify/Evaluate Feasible Energy Conservation Measures shortly referred to as ECMs
8. Economic Analysis
9. Prepare a Report Summarizing Audit Findings
10. Review Recommendations with Facility Management

Depending on the nature of the facilities the above steps may be shortened and the scope reduced thereby rendering it to a 3, 4 or 5 stage Audit. Detailed explanations on the above are provided in the following section.

Energy Audit Methodology –Detailed

1. Interview with Key Facility Personnel

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During the initial audit, a meeting is scheduled between the auditor and all key operating personnel to kick off the project. The meeting agenda focuses on: audit objectives and scope of work, facility rules and regulations, roles and responsibilities of project team members, and description of scheduled project activities.

In addition to these administrative issues, the discussion during this meeting seeks to establish: operating characteristics of the facility, energy system specifications, operating and maintenance procedures, preliminary areas of investigation, unusual operating constraints, anticipated future expansions or other concerns related to facility operations.

2. Facility Tour

After the initial meeting, a tour of the facility is arranged to observe the various operations first hand, focusing on the major energy consuming systems identified during the interview including the architectural, lighting and power, mechanical, and process energy systems.

3. Document Review

This process involves the review of the facility documentation collected during the initial visit and subsequent kick-off meeting. The review is carried out with the facility representatives and the documentation should include all available architectural and engineering plans, facility operation and maintenance procedures and logs, and utility bills preferably for the previous three years. It should be noted that the available plans should represent "as-built" rather than "design" conditions.

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Otherwise, there may be some minor discrepancies between the systems evaluated as part of the audit and those actually installed at the facility.

4. Facility Inspection / Data collection

After a thorough review of the construction and operating documentation, the major energy consuming processes in the facility are further investigated to gain understanding of their behaviour during the operations. Where appropriate, field measurements are collected to substantiate operating parameters.

The following areas should be focused to collect data for performing an energy audit.

a) **Lighting**: Making a detailed inventory of all lighting is important. Data should be recorded on numbers of each type of light fixtures and lamps, wattages of lamps, and hours of operation of groups of lights. A lighting inventory data sheet should be used to record this data. Using a light meter, the auditor should also record light intensity readings for each area. Taking notes on types of tasks performed in each area will help the auditor select alternative lighting technologies that might be more energy efficient. Other items to note are the areas that may be infrequently used and may be candidates for occupancy sensor controls of lighting, or areas where day lighting may be feasible.

b) **HVAC Equipment**: All heating, air conditioning and ventilating equipment should be inventoried. Prepared data sheets can be used to record type, size, model numbers, age, electrical specifications or fuel use specifications, and estimated hours of operation. The equipment should be inspected to determine the condition of the evaporator and

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condenser coils, the air filters, and the insulation on the refrigerant lines. Air velocity measurement may also be made and recorded to assess operating efficiencies or to discover conditioned air leaks. This data will allow later analysis to examine alternative equipment and operations that would reduce energy costs for heating, ventilating, and air conditioning.

c) **Electric Motors**: An inventory of all electric motors over 1 horsepower should also be taken if necessary. Prepared data sheets can be used to record motor size, use, age, model number, estimated hours of operation, other electrical characteristics, and possibly the operating power factor. Measurement of voltages, currents, and power factors may be appropriate for some motors. Notes should be taken on the use of motors, particularly recording those that are infrequently used and might be candidates for peak load control or shifting use to off-peak times. All motors over 1 hp and with times of use of 2000 hours per year or greater, are likely candidates for replacement by high efficiency motors- at least when they fail and must be replaced.

d) **Water Heaters**: All water heaters should be examined, and data recorded on their type, size, age, model number, electrical characteristics or fuel use. What the hot water is used for, how much is used, and what time it is used should all be noted. Temperature of the hot water should be measured.

e) **Waste Heat Sources**: Most facilities have many sources of waste heat, providing possible opportunities for waste heat recovery to be used as the substantial or total source of

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needed hot water. Waste heat sources are air conditioners, air compressors, heaters and boilers, process cooling systems, ovens, furnaces, cookers, and many others. Temperature measurements for these waste heat sources are necessary to analyze them for replacing the operation of the existing water heaters.

f) **Other Energy-Consuming Equipment**: Finally, an inventory of all other equipment that consumes a substantial amount of energy should be taken. Commercial facilities may have extensive computer and copying equipment, refrigeration and cooling equipment, cooking devices, printing equipment, water heaters, etc. Industrial facilities will have many highly specialized process and production operations and machines. Data on types, sizes, capacities, fuel use, electrical characteristics, age, and operating hours should be recorded for all of this equipment.

5. Staff Interviews

Subsequent to the facility inspection, the audit team meets again with the facility staff to review preliminary findings and the recommendations being considered based on those findings. Given that the objective of the audit is to identify strategies and measures that have high value to the customer, the involvement and inputs of the management at this point in time, helps establish the priorities that form the foundation of the energy audit. In addition, interviews are also scheduled with key representatives designated by the facility as having information relevant to the energy audit. These representatives may include suppliers and operators of specialized equipment such as HVAC, Building Management Systems (BMS),

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pumps, major energy consuming system service and maintenance contractors and utility representatives.

6. Utility Analysis

The utility analysis is a detailed review of energy bills from the previous 12 to 36 months. This should include all purchased energy, water, as well as any energy generated on site. If possible, energy data is obtained and reviewed prior to visiting the facility to insure that the site visit focuses on the most critical areas. Billing data reviewed includes energy usage, energy demand and utility rate structure. The utility data is normalized for changes in climate and facility operation and used as a baseline to compute projected energy savings for evaluated Energy Conservation Measures ECMs.

7. Identify/Evaluate Feasible ECMs

Typically, an energy audit would lead to several measures aiming to conserve the resources. They may vary from a simple operation related changes that may yield a simple and quick payback to a full-fledged major revamp and major facility modifications that requires models, simulations, elaborate economic analysis and feasibility. In other words the ECMS vary from Low cost or No cost option to an option requiring considerable funding.

A list of major energy conservation measures (ECMs) is developed for each of the major energy consuming systems (i.e., envelope, HVAC, lighting, power, Water and process). Based upon a final review of all information and data gathered about the facility, and based on the reactions

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obtained from the facility personnel at the conclusion of the field survey review, a finalized list of energy conservation measures (ECMs) is developed and reviewed with the facility manager.

8. Economic Analysis

Data collected during the audit is processed and analyzed back. A detailed methodology is devised to create the baseline and establish a means of measuring the energy savings from the ECMs. Through this process, the saving potential of the ECM is ascertained. The methodology may include simulation, models and use of other software for this purpose. This step also includes identifying the cost of implementation of the ECM and a simple payback of the ECM.

9. Prepare a Report Summarizing Audit Findings

The results of the findings and recommendations are summarized in the final report. The report includes the executive summary, a description of the facilities and their operation, a discussion of all major energy consuming systems, a description of all recommended ECMs with their specific energy impact, implementation costs, benefits and payback. The report incorporates a summary of all the activities and effort performed throughout the project with specific conclusions and recommendations.

The report would outline the objectives and scope of audit, description of characteristics and operational conditions of equipment/systems audited, findings in the audit, ECMs identified, corresponding savings and implementing costs, recommendations on ECM implementation program and any other follow-up actions.

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10. Review Recommendations with Facility Management

A formal presentation of the final recommendations is presented to facility management to furnish them with sufficient data on benefits and costs to make a decision on which ECMs are to be implemented.

Energy Auditor's Toolbox

The following instruments are generally used to conduct an efficient energy audit for existing buildings

1. Measuring Tape
2. Light Meter
3. Thermometer
4. Volt Meter
5. Wattmeter/ Power Factor Meter
6. Combustion analyzer
7. Airflow measuring devices
8. Current loggers
9. Temperature loggers
10. Btu meters and loggers
11. kWHrs meters and loggers

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Remarks

In view of the fact that there is tremendous potential for energy savings, it is strongly suggested that the owners and operators of the existing facilities explore the possibility of undertaking auditing of their facilities in a form and scale that is suited to them.

The above guideline provides a broad outline of the elements involved in auditing a typical facility and is intended purely to familiarize the user to the common terms used in the process. This guideline should however not be construed as a scope that is specifically required by Trakhees towards compliance.

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