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Urban Energy Technical Note

Energy Audits

Nowadays, over 75% of the world's energy generation is consumed in urban areas alone and more than half of that is consumed in buildings. This has a major impact on our environment and contributes to climate change.

In Africa, where the urban population is increasing at a rate of 3 to 4% annually, the construction industry is playing a major role in energy consumption. The contribution buildings make to climate change and greenhouse gas emission is directly linked to the way they are designed in relation to the local climate, to site specific characteristics, to the embodied energy of the materials used and to the entire construction process. The lack of proper planning and of integration of passive building principles into new buildings is drastically increasing energy consumption in buildings.

In order to address these challenges, urban planning and building design methodologies that are energy conscious and environmentally friendly need to be adopted. However, to do this, it is crucial to understand how much energy is used in buildings and for what purpose. This is usually done though energy audits.

What is an Energy Audit?

An energy audit is simply defined as a survey or study to identify how energy is being used in a building or plant by:

- establishing its energy consumption profile;
- finding out the cost of energy use in the building or plant;
- investigating the various energy saving opportunities that exist in order to reduce consumption.

Benefits of Energy Audits

Energy audits present an opportunity for the correct implementation of energy efficiency strategies in buildings. This in turn has several benefits that include the following:

- **Financial:** through energy savings and therefore reduced operational costs and increased profits;
- **Indoor comfort:** through better indoor environmental quality that results to improved occupant productivity;
- **Environmental:** through the avoidance of Greenhouse gas (GHG) emissions due to resource efficiency and reduction of energy demand on the national grid.

Types of Energy Audits

The scope of the project and the level of details desired determine the type of energy audit required. There are four basic types of energy audits whose main difference is the level of complexity and the depth of the data analysis. The different types, in order of increasing complexity are:

The Benchmarking Audit

This involves a preliminary analysis of energy consumption and costs based on utility bills, by determining benchmark indices such as kWh per unit area per year and cost of energy per unit area per year.

The Walk-through Audit

This type of audit involves a tour of the facility to briefly survey the building's condition and evaluate its current energy consumption data by assessing the available energy bills.

Save energy and money: just two of the many great motivations to conduct an energy audit!

Standard Audit

This is a more detailed energy audit where the building's characteristics are completely analysed. More time and resources are required as it also includes evaluation of the building's detailed energy demand and consumption (which is broken down into different end-uses such as heating, cooling, lighting, appliances, and hot water production).

Computer Simulation

For this level of audit, computer simulation software is used for a more comprehensive evaluation of energy consumption patterns that takes into account weather and other variables and predicts year-round energy consumption. Its goal is usually to develop a baseline for comparison with the actual energy consumption of the building. Due to the time involved collecting detailed information about the building, operational data and setting up of the baseline model, this is the most expensive level of energy audit. However, it is useful if the facilities are more complex in nature.

This Urban Energy technical note focuses on the methodology for a walk-through Energy Audit.

The Walk-through Energy Audit process

The walk-through energy audit gives a quick overview of the energy consumption patterns, identifies energy inefficiency if any and presents an opportunity to collect information for a more detailed audit later.

The process may be split into three distinct stages that will help in collecting useful information and reducing the amount of time spent evaluating the relevant building as shown in Figure 2.

Fig. 01: **Stages of energy audits and the tasks involved**

PRE-SITE WORK	SITE VISIT	POST-SITE WORK
Collecting and analysing historic utility data - at least 12 months of electricity bills	Confirming sketch / drawings of actual building.	Review and clarification of notes taken during the site visit.
Establishing occupancy rates at different times of the year under different climatic conditions	Taking dimensions of building façades, openings, roofs, floors, shading devices etc. The following tools are necessary for this task: notebooks/sketch pad, tape measure, calculator, camera, mini data loggers, flashlight, light meter etc.	Identification of the annual trends, monthly variations of energy consumption and cost implications from the electricity bills collected. These trends should be identified and cross checked with climatic data of the year under assessment.
Obtaining architectural, electrical and mechanical drawings if available for review.	Documenting the existing conditions by taking pictures of façades, surroundings, equipment, interior spaces, lighting etc. as one walks through the building.	Proper classification of the building envelope elements (roofs, walls, slab, doors, windows, glazed surfaces etc.) by orientation, material type and U-values.
Preparing a simple sketch of the building in case the plans are not readily available.	Recording the type, quantity, quality, year of installation / manufacture and location of relevant equipment, appliances and artificial lighting devices.	Identification of potential energy saving opportunities.

Fig. 02: **Tools used in energy audits**

A simple energy audit checklist

With a simple walk-through energy audit, one can spot existing energy related problems in any type of building using a simple checklist, such as the one in Table 01 below.

This checklist is useful in identifying any problem areas the building may have thus enabling one to make energy efficient changes that may help in significantly lowering energy consumption and consequently energy related costs.

Table 01: **Walk-through energy audit checklist**

GENERAL INFORMATION

- Building category
- Climatic zone
- Occupancy profile
- Year of construction
- Year of the last major renovations

SITE & BUILDING DESCRIPTION

- Topography
- Location context
- Site and building orientations
- Sketch of site and building layout showing plot coverage
- Physical description of building (no. of floors, ceiling height etc)

BUILDING ENVELOPE

- **Facade**
  - Orientation
  - Surface area
  - Materials
  - External & internal finishes
  - Thickness
- **Windows**
  - Orientation
  - Type of window
  - Surface area
  - Type of glass
  - Glass thickness
- **Roof**
  - Type of roof
  - Orientation & slope
  - Surface area
  - Roof material
  - Thickness
  - Roof overhang
- **Floor**
  - Type of floor
  - Surface area
  - Material
  - Thickness
- **Shading devices**
  - Orientation
  - Position - external or internal
  - Type of shading device - fixed or mobile
  - Material

VENTILATION

- **Natural ventilation**
  - Room orientation
  - Type - stacked, cross etc
  - Presence of permanent ventilation
- **Mechanical ventilation**
  - Room orientation
  - Type (fan, split AC, ducted system etc.)
  - Capacity
  - Efficiency
  - Year of manufacture
  - Year of installation
  - Date of last maintenance

LIGHTING

- **Natural lighting**
  - Room orientation
  - External opening orientation
  - Area of external opening
- **Artificial lighting**
  - Type and number of fixtures
  - Average watts per fixture
  - Operating hours / day
  - Presence of sensors

APPLIANCES

- Type and number of appliances
- Capacity in Watts
- Number of hours used per day

ELECTRICITY CONSUMPTION

- Availability of electricity bills (at least 12 months)
- Consumption of energy in kWh / month
- Monthly cost of electricity

NON ELECTRIC ENERGY USE

- Type of fuel source:
  Electric, Liquefied petroleum gas, Paraffin, Charcoal, Firewood, Solar, Batteries, Diesel generator etc.
- Average consumption in litres/Kgs per month
- If there is a generator - the capacity in kWh, frequency of use etc.

WATER

- Source of water - council mains, borehole etc.
- Rain water harvesting
- Average water consumption - daily, monthly.
- Waste water recycling
- Domestic water heater - number, capacity (kW), volume, type of heater.
- Water storage - capacity in litres

Energy rating labels

Energy rating labels are found on many appliances and equipment such as fridges, freezers, washing machines, tumble dryers, dishwashers, electric ovens, air conditioners, TVs etc.

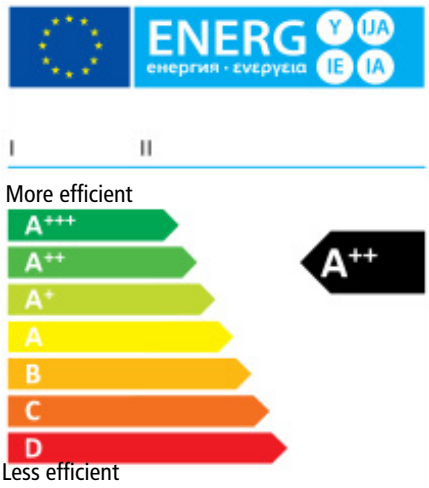
They provide information on the energy efficiency of a product. The more energy efficient a model is, the less energy it will use and consequently the lower the running costs.

The purpose of these energy labels is to make it easy for consumers to identify and buy energy-efficient products thus saving on energy bills without compromising on the performance required of the appliances / equipment.

Most energy labels are rated from A - G, with A being the most efficient and G being the least efficient. They usually give the following information:

- Energy efficiency star rating: the more stars it has, the more energy efficient the appliance / equipment is;
- Energy consumption in kilowatt-hours (kWh) per year: the lower the kWh figure, the less energy the appliance / equipment will use;
- Relevant test standards of the appliance / equipment;
- Manufacturer and model information.

Fig 03: **Examples of energy rating labels**



This EU energy label is the most common energy rating label.

This logo, usually found on equipment such as computers, printers and fax machines, means that the consumption of the appliance is below an agreed method in stand-by mode.

Energy saving tips

- Replace incandescent bulbs with energy efficient LED lights or high-efficiency compact fluorescent lamps (CFLs).
- Unplug electronics when they are not being used. This includes turning off gadgets that are on standby.
- Turn off lights when not in use.
- Consider going solar for water heating systems.
- Choose appliances and equipment with good energy rating labels.
- Use a fan instead of an air-conditioner to keep cool (if necessary).
- Use motion sensors and dimmer switches.
- When using a washing machine, run full loads when possible and wash the clothes in cold water.
- Consider using a clothes line instead of a drier to save energy.
- Cooling indoor spaces naturally by opening windows rather than using air conditioning will reduce energy consumption.

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