

" ENERGY EFFICIENCY IN BUILDINGS "

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1. Introduction

Energy in all of its forms is becoming increasingly important in the modern technological world. Unlike in the past, the price of energy is a sensitive issue in every day life. In view of this there is a considerable emphasis on research and development into renewable sources, use of efficient energy consumption equipment, management of utilization of energy and energy conservation. Many organizations and establishments around the world are pursuing this both at local and international level. The European Union's proposal of a Single Energy Market among its member countries, well reflects the amount of thought and attention given to energy production and its usage in an optimum manner.

Sri Lanka as a developing country and aiming at achieving NIC status in the near future, needs to consider providing reliable and rationally priced Energy as a top priority. The main source of energy used in Sri Lanka are Biomass, Petroleum and Electricity. LPG & Coal are used in a smaller scale. Due to the boost in industry and service sector in Sri Lanka within the past few years, the demand for electrical energy rose to an unprecedented level. With this and other constraints in supply of electrical energy Sri Lanka is anticipating a Power Crisis within the next 2-3 years .

Energy use for lighting, air conditioning, ventilation and other services in Public and Industrial Buildings in Sri Lanka is rapidly increasing , presently accounting for over 30% of electricity sales. Most buildings use excessive artificial lighting and air conditioning, which are the results of inefficient building designs and poor operating practices.

Conservation of energy has become important in industrial & commercial sectors, thus making Energy efficiency in buildings an appropriate and timely subject to be dealt with.

Present Building Codes do not specify energy efficiency requirements. Building designers either copy the standards from other countries inappropriate to

the society and the climate of Sri Lanka or completely neglect standards.

SLEMA, being the only professional body dedicated solely to the Energy Sector, proposed a research project titled " Energy Efficiency in Buildings " to Swedish Agency for Research & Co-operation (SAREC) through Natural Resources, Energy & Science Authority (NARESA) for the purpose of obtaining funds. The SAREC has agreed to fund this project.

The initial phase of the project will be a research study of existing buildings to establish baseline data on present energy use, types of equipment and control devices. The research on lighting requirements for different tasks through a country-wide sample survey and laboratory condition will follow. Simultaneously, research would be conducted to investigate air conditioning and ventilation requirements and the design of buildings for optimum thermal efficiency.

Information collected and research results will then be used to develop a building energy code for Sri Lanka. It is expected that the code recommended by the research team will be finally adopted as an official code of practice at the completion of the project.

2. Background

The demand for electricity in Sri Lanka is growing at over 8% per year. The predominantly hydroelectric power generating system requires more and more expensive thermal generation with consequent environmental impacts. The price of electricity is rising too, presently sold at Rs. 4.40 per kilowatt-hour.

Most of the recent growth and that of the immediate future is expected to be in the services and industrial sector. A substantial portion of consumption in service sector will be for artificial lighting, air conditioning and other services in public and industrial buildings. Public buildings are offices, hotels, supermarkets, shops, schools, hospitals, etc. For example, in certain part of the City of Colombo, there is a day-time peak electricity demand (which

is attributed to lighting and air conditioning in public buildings) whereas in the rest of the country, has an evening peak demand (which is attributed to lighting in the households).

The building designers and architects have no guidelines or codes of practices to follow to make their designs energy efficient. Daylight available in abundance for 12 hours a day is not adequately utilized in the new buildings. There are no standards in Sri Lanka on lighting requirements for various tasks. Different designers use different standards, some of which are not appropriate for Sri Lanka. There are no guidelines on building designs for thermal efficiency and to conserve energy, resulting in poor designs which then require expensive ventilation, air conditioning and artificial lighting. Buildings which are designed for air conditioning seldom conform to any code of practice with energy efficiency in mind and are therefore expensive to operate.

Sri Lanka has a building code implemented by the Urban Development Authority which specifies the requirements of lighting and ventilation within buildings and in open spaces around buildings. These contribute towards energy efficiency to some extent, but do not cover sufficient requirements to achieve energy conservation and efficiency in a comprehensive manner. The development of energy efficiency codes for buildings require a thorough understanding of the design aspects of buildings in Sri Lanka, the perceived levels of lighting and ambient conditions within buildings and the operation, maintenance, control of energy using equipment. There are no research studies conducted in Sri Lanka on any of the aspects required to develop a building code, except the study on daylighting (De Alwis, 1993).

3. Objectives of Project

- (a) Develop research capacity in Sri Lanka in the area of Energy efficiency and conservation in buildings, both from the users' perspective and from the designers' ability to optimize building designs,
- (b) Conduct research on the present energy usage patterns, requirements of lighting for different tasks, requirements of ambient conditions within buildings and

maintenance / operation / control of energy consuming equipment,

- (c) Study on building energy codes and their basis in other countries, and to develop a draft energy efficiency code for buildings in Sri Lanka.

4. The expected contributions of the project

- (a) The determination of the relationship between visual performances and illuminance levels and optimise the acceptable levels of illuminance as related to the Sri Lankan society.
- (b) The quantities and efficiency of present-day energy use in public buildings of Sri Lanka (which will have far reaching advantages in the planning and implementation of electricity demand-side management projects in addition to providing vital information to develop the building energy codes during this project)
- (c) The development of a code of practice on efficient energy use in buildings of Sri Lanka.

The outcome of the project is a draft building energy code for Sri Lanka based on the research conducted during the project. This building code will be incorporated to the already available code covering energy aspects. Engineers and Architects will be required to conform to this code of practice. Significant saving in energy consumption is expected in the new buildings when compared to those constructed at present. The overall saving in energy is significant with far reaching economic and environmental benefits to the country.

5. Research Methodology

SECTION I- Base line consumption research

The objective of the research is to identify the Energy Consumption patterns, specific energy consumption and energy-related control systems in commercial buildings.

The methodology is described below.

(a) About 1000 buildings will be selected for the survey according to the following classification. Buildings will be categorized into the following four main areas.

- i) Fully air-conditioned
- ii) Partially air-conditioned
- iii) Non air-conditioned
- iv) Hotels

Among the above categories category (i), (ii) and (iii) will be further divided into subcategories on the basis of the floor area.

Category (iv) will be further divided as follows :
Five Star hotels, Four Star hotels, Three Star hotels.

(b) A **preliminary survey** will be conducted to collect energy consumption data and floor area, in order to calculate the specific energy consumption.

Four buildings from each category will be selected for the **detailed survey**. Under this detailed survey, the following information will be collected. Lighting levels, types of lighting devices, types of air-conditioners and air-conditioner control systems, Other energy control systems (fans, escalators, refrigerators).

The **Comprehensive survey** that will follow includes Daily load curve, Energy consumption for air-conditioning, lighting and other services, Operating practices and settings of air conditioner control systems, refrigerator performance, temperature controllers and controller settings, elevator and escalator energy use, operating practices and control systems, lighting control systems and their use

A **literature survey** would be conducted to collect information about building energy standards and norms in the countries of the region. This survey would also include standards for types and settings for energy control devices.

A limited **market survey** would be conducted to assess the availability and costs of energy control devices used in buildings.

SECTION II- Lighting Research

A comprehensive study would be carried out on a range of selected common activities to determine the visual performance and illumination levels.

The study methodology would be the following:

Selection of Tasks, Conditions under which the studies should be carried out, Selection of 'Subjects, Subjecting them to an optometric and any other relevant ophthalmological examinations, deciding on the types of Visual Performance tests to be carried out, Fixing a Visual Performance level to be achieved (70% - 80% - 90% etc.), Determining the optimum illuminance values, which ultimately would be the 'recommended values' - being well above obligatory minima.

The three principal areas selected are OFFICES, MANUFACTURING INDUSTRY and HOTEL INDUSTRY. Of these too only specific tasks would be considered.

Offices will be categorised into following :

Category I General office work, carried out in small, medium and deep plan offices, employing over 10 workers.

Category II Computer operation, typewriting and other office machine operation areas.

Category III Drawing Offices: Tasks of 'Critical Contrast', 'Critical Size of detail' and Intense and continued attention.

The manufacturing industry will be divided into three broad categories:

Category I Garment manufacturing industries: At sewing machines, cutting tables, matching functions, pressing, inspecting/quality control.

Category II General Manufacturing industry: Iron and Steel, Rubber and rubber products, Plastics and allied industries, textile, paper, Ceramics and others.

Category III Electronic and other specific industries

HOTEL INDUSTRY, usually patronized by people from developed countries, accustomed to living under high levels of illuminance.

Reduced levels of illuminance, to suit local conditions, in the following areas. (a) corridors, (b) bedrooms (General & Bedhead), (c) bathrooms (General), (d) kitchens (General) and (e) food stores (General)

Studies would be carried out both under controlled laboratory conditions as well as under field conditions, depending on the nature of the task.

SECTION III - Research on Thermal Efficiency

This section of the methodology aims to develop a suitable approach leading to a standard or a codes related to the Building Envelop. This would then set a minimum requirement for the efficient design of new buildings so that they may be applied at construction stages.

In the absence of extensive laboratory facilities and instrumentation to examine, review and re-evaluate the thermal comfort levels in compliance with Sri Lankan climate and social conditions (specially with reference to the air conditioned and non air conditioned spaces), the work will be based on the data and information drawn from section I (the base line survey) and similar work carried out in the tropical developing countries. In this regard, an extensive literature survey will be carried out to see as to how the compliance with the performance index characterising the building envelop is determined. Special attention will be paid to non - air conditioned building envelops.

The results of the base-line survey of section I will be correlated to this performance index thereby definitely establishing an acceptable threshold for this performance index to suit our climatic conditions. This quantitative technique will form the base for

establishment of proper standards.

SECTION IV- Building Codes

A Comprehensive review will be conducted on the building codes in other developing countries in the region and the developed countries.

Using the research results of sections I, II, and III, a draft building energy code will be prepared.

The draft building code will be presented at a workshop of architects, engineers, city planners and regulatory authorities in Sri Lanka, with advisory participation of at least 2 international experts. Comments will be incorporated in the final version of the draft building energy code that will be published at the end of the project.

6. Implementation of the Project

The project got underway with a launching seminar held in December 1994, which was attended by many professionals from reputed organizations in Sri Lanka, and the program officer for Sri Lanka from SAREC. Four papers were presented on each of the above sections of Research Project, by the respective section leaders. A thorough discussion session followed where valuable views and suggestions regarding the context of the project which were incorporated in the research study.

For the research work, there will be one research student for the section of lighting research, and two research assistants for the sections of Thermal efficiency and Building codes. Overall management of this project will be handled by a Project Manager, working on a full time basis.

A group of Sri Lankan professionals belonging to the relevant fields of the project and a Professor of Royal Institute of Technology, Sweden & his team of researchers will be rendering their services during the entire project period of three years.