CHAPTER 1

INTRODUCTION

Energy is a basic requirement for the existence and development of human life. Primarily, the commercial sources such as fossil fuels (coal, oil and natural gas), hydroelectric power and nuclear power provide the energy needs of a country. The demand for energy is growing at an alarming rate year after year. For example, according to International Energy Agency (IEA), the global consumption of energy has increased from 4606 Mtoe (million ton oil equivalent) in 1973, to 7287 Mtoe in 2003. On the other hand, the fossil fuels are rapidly depleting and the era of fossil fuel is gradually coming to an end. The accelerated demand and the depletion of resources have caused a steep hike in the cost of fossil fuel. Besides, the combustion of fossil fuels has caused air pollution resulting in global warming and ozone layer depletion. In addition, the release of harmful gases into the atmosphere is causing serious problems for living organisms. Similarly, the release of large amounts of waste heat from power plants to water bodies causes water pollution. In case of large hydroelectric power projects, submerging of land — thereby destroying valuable plant life and displacing inhabitants — has become a serious concern. The fear of release of radioactivity into the atmosphere in the event of an accident or from nuclear waste has forced people to reconsider the use of nuclear power. In view of these problems associated with conventional energy sources, the focus is now shifting to conservation of energy, and to the search for renewable sources of energy that are also environmentally benign.

With the increase in standards of living, the consumption of energy in buildings is progressively rising. The boom in building sector is going to create further demands, resulting in greater pressure on the energy supply situation. In this context, the conservation of energy in buildings through appropriate construction, operation and maintenance practices assume prime importance.

The primary function of a building is to provide a comfortable indoor environment. Traditional buildings of earlier times had many built-in architectural features for achieving comfort. Unlike animals and birds that build their shelters intuitively and adapt themselves to environmental changes, man has relied on various resources to build shelters for protection from heat, cold and rain. They are shaped and planned to take maximum advantage of the climate and surroundings. Gradually, as newer materials and techniques of construction developed, vernacular built forms evolved to provide a harmonious balance between buildings, climate and people's lifestyle. A number of passive solar techniques were adopted in vernacular architecture in the various climatic zones. Control of the microclimate around the building was always

an important design consideration. While planning a town, care was taken to orient the streets keeping the effects of sun and wind in mind. For example, towns in Gujarat and Rajasthan, which experience a hot and dry climate, had rowhouses with common walls. These were tightly packed along with streets and lanes to minimize exposure to direct sun and hot winds. The front façades were further shaded with well-articulated balconies called “jharokhas”. Each house had an open courtyard which acted as an exhaust for warm air and provided enough natural light for the interior of the house.

With technological advancement, people failed to continue the tradition of maintaining harmonious balance between buildings, climate and their lifestyle. Modern architecture has become a “conquest” of nature in the sense that, environmental conditions notwithstanding, a building could be given a sleek, clean and well-proportioned exterior façade, and the interior made as comfortable as required with the help of artificial devices. However, the drawback is that, such buildings consume an enormous amount of energy.

A growing worldwide concern for conservation of energy has reawakened interest in ecologically sustainable materials, processes and sources of energy. With the availability of newer materials and techniques, and with changing demands on built spaces, achieving thermal and visual comfort in buildings has become a design challenge for modern architects, building engineers and scientists. Various analytical methods have been developed using which, the techniques evolved in the past are now scientifically understood, appropriately quantified and improved. These have led to the evolution of *energy conscious building*. Energy conscious building involves the use of eco-friendly and less energy intensive materials, incorporation of passive solar techniques (including day lighting features) and integration of renewable energy technologies. It also includes conservation of water and waste water recycling, rainfall harvesting and the use of energy-efficient appliances in buildings. For example, in a commercial building, the cooling load can be saved by about 26% in a hot and dry climate (like Jodhpur) by adopting appropriate design considerations and operation strategies. Simple design procedures such as orientation, shading, insulation, etc. can be easily incorporated in any building, leading to substantial benefits from the point of view of comfort and energy savings. In some climates, simple techniques alone may not be adequate for achieving ideal comfort conditions. In such cases, advanced features such as wind tower, roof pond, Trombe wall, etc. may be used. Even in conditioned buildings, where mechanical devices are used to create a comfortable environment, the use of passive methods would help reduce the energy consumption. Further, the integration of photovoltaic systems as well as active systems such as hot water or hot air systems would further reduce the consumption of conventional energy.

In spite of access to a large information base and pioneering work in this field, the idea of energy conscious design approach has is not quite caught on. The expertise developed at various institutes in India has not percolated to architects at large, especially in a form that can be directly implemented in their designs. This book endeavours to orient practising architects towards the importance and benefits of energy conscious building.

A brief outline of each chapter of the book is as follows:

Chapter 2 presents basic information regarding climate and its effects on buildings. A description of the characteristics of the different climatic zones of India is given.

The principles of passive solar architecture including simple and advanced techniques are described in detail in *Chapter 3.* Wherever possible, the principles are also accompanied by the details of construction. Additionally, day lighting is described separately as a passive solar technique.

The thermal performance of a conditioned building refers to the estimation of its heating and cooling loads, energy demand, and sizing and selection of HVAC equipment. For a non-conditioned building, it is the calculation of temperature variation inside the building over a specified time, and the estimation of uncomfortable periods. The quantification of these aspects determines the performance of a building design and helps in evolving improved designs for achieving comfortable indoor conditions. *Chapter 4* presents the basic concepts that enable an architect to understand the various aspects of estimation of the thermal performance of a building design.

Chapter 5 provides guidelines on passive techniques for three types of buildings, namely, commercial, industrial and residential buildings. Because the design of passive solar buildings is climatic specific, the guidelines have been structured climate-wise.

The integration of renewable technologies in building design, conservation of water and rain water harvesting are discussed in *Chapter 6.*

Chapter 7 presents a few case studies to illustrate the use of various passive techniques and new building materials.

A technical glossary and a number of appendices containing useful information supplement the main chapters.
