

# Preface

With the growing concern for environmental degradation and specifically climate change problem, energy sector all over the world is facing the difficult challenge to meet the ever-increasing energy demand with minimum/no degrading effects on the environment in an economic way. Energy is a vital component for modern civilization, and often per capita consumption of energy is considered as the index of life standard of people of a country. Supplying energy for a decent living at an affordable price and in an environment-friendly way is the critical challenge.

Sustainability is the concept of meeting the present demand without compromising the needs of the future generation. Optimum planning of use of natural resources to meet the need of the present as well as future generations is very critical for sustainability. Solutions must be socially and environmentally acceptable as well as economically feasible. For a long period, fossil fuels were the main source of useful energy for rapid development of human civilization. Technologies for using these fuels have matured over a long period and are available at an affordable cost all over the world. However, limited remaining reserves of these fuels have forced energy technologists to explore alternative options. On top of that, climate change problem may force us to 'leave fossil fuels before they leave us.' Renewable resources are considered to be only future options of energy in a longer time frame as these are virtually inexhaustible. However, technologies for using different renewable resources are widely varying and most of them are still developing. Economic feasibility as well as social acceptance of these new options has to be checked thoroughly before they can emerge as reliable options for future. Intermittency of most of these resources is another problem. These are to be used when 'these are available rather than when we need these for our use.' Different ways of addressing this challenge are under active investigation, including suitable technology development for energy storage and 'hybridization' of different resources available locally. Thus, solutions may be site specific and no unique solution may be available for the whole world. Removing fossil fuels immediately may not be a feasible solution too as other options are neither capable to meet the huge demand nor their reliability is assured under all possible adverse situations. Also, a large capital is already 'locked' in fossil fuel-based technologies. A planned

smooth phasing out of these technologies is required with the development of alternative ones within a specified time frame. This needs proper energy policy with multilevel governance. Moreover, suitable change of existing fossil fuel-based technologies during this transition is critical, most specifically due to climate change problem. Energy sustainability is a global challenge, though many issues of it are site specific. Addressing energy sustainability is thus a global issue as well as local one—starting from a country even up to a small village of that country.

Sustainability of Indian energy sector needs thorough introspection. Presently, coal dominates with 54% of installed generation capacity and ~69% in terms of actual power generation. Also, most of these coal-based power plants are of conventional PF fired with low efficiency. Large transmission and distribution losses with minimum environmental regulation are other limitations of these plants. Hydropower has the next largest share (21% of total installed). Other renewable and nuclear power have steady growth but with some constraints—technological, social, economical, and even political. Transport sector is mostly dependent on imported oil with large uncertainty, economical as well as political. Traditional sources of energy also have a good share, though decreasing. To have a sustainable plan for the Indian energy sector, assessment of the present scenario and future planning based on this assessment is very urgent.

In two volumes of this book, experts from all over the world have addressed energy sustainability from different viewpoints in several articles. Specifically, Indian energy sustainability is also explored with a background of this global perspective.

In the introductory chapter, Sikdar has reported his perception about the different terminologies, say, clean, green, and sustainable energy. Solar photovoltaic technology is considered to be one of the most widely used renewable technologies worldwide as an alternative to fossil fuel-based electricity. Roy discussed this technology starting from the very basic fundamentals up to the most advanced research findings in this field. Integration of intermittent renewable electricity to the conventional grid is a real challenge. Microgrids are considered to be emerging solutions for utilizing different distributed intermittent renewable energies. N. K. Kishore et al. have presented an overview of the present status of microgrids. Transmission and distribution losses affect the overall energy efficiency. Lakshmi and Ganguly presented a state-of-the-art review of transition of power distribution systems. Distributed generation is emerging as a sustainable solution in place of large-scale fossil fuel-based energy systems. Iaria et al. have reported such a system using solar energy. Design of this system has been developed up to the full-scale implementation. Unexplored potential of distributed generation in India has been reported by Jana and De. Full utilization of this potential may make a paradigm shift of energy sustainability of India. Delivery of multiple utility with single or multiple inputs is called polygeneration. It increases the overall energy efficiency with optimal design. A mathematical optimization process using linear programming for such systems has been discussed by Tan and Aviso. Though increasing renewable share is always desired, fossil fuel-based electricity will continue to remain as the major source of electricity. Detoxification technology during

processing of crude oil has been reported by Jarullah et al. CO<sub>2</sub> capture is required to use fossil fuels in power plants in a longer time frame. Different technologies are being developed for this purpose. An overview of state of the art of this technology has been discussed by Maria et al. Prospects of use of algae specifically for this purpose have been discussed by Chowdhury et al. In spite of all challenges, coal plays a critical role in energy sustainability of India. This complex issue is addressed by Bhattacharyya, former chairman of the largest coal producing company of India. Finding new fuels and to use those in innovative ways also add to future energy sustainability. A chapter on use of gas hydrates has been contributed by Nair et al. Biofuel is undoubtedly one important option to substitute fossil fuels in future, specifically in transport sector. Several chapters discuss this important issue both from global perspectives as well as in Indian context. Two chapters by Verma and Kishore and other two by Chowdhury et al.; Yadav and Sen discussed different aspects of biofuels. Energy sustainability cannot be achieved without improving energy efficiency. Building energy efficiency is considered to be a very important issue for future energy sustainability. Two chapters by Azad and Rakshit; Saikia et al. discussed this important issue including Indian context. In the concluding chapter, possible energy efficiency measures in a milk plant of India have been discussed by Srinivasan et al.

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