

ENERGY RESEARCH 4B

RENEWABLE ENERGY SOURCES: INTERNATIONAL PROGRESS

PART B

EDITED BY

T. NEJAT VEZIROĞLU

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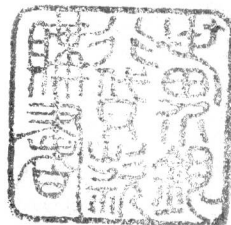
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PART B

Proceedings of the International Symposium-Workshop on Renewable
Energy Sources, Lahore, Pakistan, March 18–23, 1983

Edited by

T. NEJAT VEZIROĞLU

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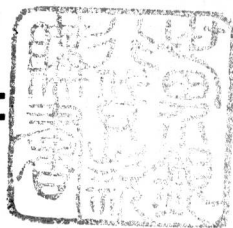
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RENEWABLE ENERGY SOURCES: INTERNATIONAL PROGRESS

Proceedings of the International Symposium-Workshop on Renewable Energy Sources, Lahore, Pakistan, 18-23 March 1983; sponsored by the Ministry of Science and Technology, Pakistan, and the National Science Foundation, U.S.A.; presented by the Clean Energy Research Institute, University of Miami, Coral Gables, Florida, U.S.A.; hosted by the Pakistan Council of Scientific and Industrial Research; and assisted by the International Association for Hydrogen Energy, the Solar Energy Society of Pakistan, and the Mechanical Engineering Department, University of Miami.

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The Symposium Committee gratefully acknowledges the Inaugural Message sent by General Muhammad Zia-ul-Haq, President of Pakistan, to the Symposium. The Committee thanks very much those officials and administrators who supported and contributed to the Symposium, and/or made addresses to the Opening Session of the Symposium: Dr. M. A. Kazi, Advisor to the President of Pakistan on Science and Technology; Dr. Edward T. Foote II, President, University of Miami; Mr. M. Masihuddin, Secretary-in-Charge, Pakistan Ministry of Science and Technology; Dr. M. Aslam, Chairman, Pakistan Council of Scientific and Industrial Research; Dr. M. D. Shami, Chairman, Pakistan Science Foundation; Dr. A. U.-R. Mufti, Director, Pakistan Silicon Technology Development Centre; Dr. O. Shinaishin, International Programs, the U.S. National Science Foundation; Dr. W. Aung, Program Director, the U.S. National Science Foundation; and Mr. C. Moseley, Chief Officer for Energy and Engineering, the U.S. Embassy, Pakistan.

Special thanks are due to our lecturers and authors, who have provided the substance of the Symposium as published in the present proceedings.

Last, but not least, our debt of gratitude is owed to the Session Coordinators, Chairperson and Co-Chairpersons, the Workshop Leaders and Associate Leaders, and all those who have helped in making the Symposium a success.

The Symposium Committee

FOREWORD

The improvement of living standards in any given region of the world is directly proportional to the increase in energy consumption by the people in that area. Two prerequisites for better living conditions are thus the availability of abundant energy sources and a well-developed technology for making use of them. Unfortunately, traditional energy sources, i.e., coal, petroleum and natural gas, are no longer as abundant as they once were, and they are rapidly being depleted because of an increasing rate of consumption paralleling the growth in world population. It thus becomes imperative to find and develop new — if possible renewable — energy sources so that the living standards of the peoples of the world can not only be maintained, but also improved.

Both renewable and nearly renewable energy sources are available, but are relatively undeveloped technologically. These energy sources, such as solar, hydro, wind, ocean-thermal, wave, tide, current, geothermal and biomass, are relatively untapped or not utilised to any significant degree. Hydrogen is a suitable synthetic fuel for most applications and has a renewable raw material base — water. It requires the development of environmentally acceptable energy sources, preferably renewable, to produce it.

Because of its importance to all nations, research into the most efficient and economical utilization of renewable energy sources is being conducted around the world. The International Symposium in Lahore, Pakistan, provided a platform for the presentation and dissemination of the latest information on renewable energy sources. Its sessions covered all the renewable energy sources, as well as research, in every aspect, from the fundamentals of energy conversion to applications, from economics to environmental considerations.

Although the Symposium covered wide areas of current research and development for the utilization of new and renewable sources of energy, all of which are extremely important in their own context, those related to rural settings deserve special mention. Developing countries like Pakistan have experienced an exponential growth in demand for energy — which, even if met adequately, has largely gone toward meeting the requirements of urban areas and industries. The rural populations have remained largely neglected, even as their underdevelopment directly contributes to the overall economic condition of the countries they comprise. Ways and means have, therefore, been suggested in the Symposium to counteract this lopsidedness in the identification and provision of renewable energy sources, along with their pollution-free and effective use by the rural populations.

The papers recommended by the session chairpersons and co-chairpersons, together with the opening session addresses, are arranged in these two volumes and divided into some 23 chapters by subject. The reader should be advised that it was difficult to classify specifically some of the papers where there was an overlap in subject matter. In such cases, we tried to make the best possible choice.

VIII

These volumes form a valuable reference for the fundamentals and utilization of the renewable energy sources, and present many examples of applications around the world, with special significance for the rural regions and developing countries, where the need for energy is greatest.

T. Nejat Veziroğlu
Symposium Chairperson & Editor

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SESSION 5E

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WORKSHOP
SESSION 5F

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