

**ENERGY DEVELOPMENTS:  
NEW FORMS, RENEWABLES,  
CONSERVATION**

Edited by  
**FRED A. CURTIS**

PERGAMON PRESS



TK01  
26

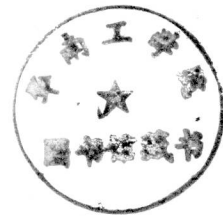
8660882

# **ENERGY DEVELOPMENTS: NEW FORMS, RENEWABLES, CONSERVATION**

---

**Edited by**

**Fred A. Curtis  
Faculty of Engineering  
University of Regina  
Regina, Saskatchewan  
Canada**



E8660882

**Pergamon Press**

Toronto • Oxford • New York • Sydney • Paris • Frankfurt

U.K.	Pergamon Press Ltd., Headington Hill Hall, Oxford OX3 0BW, England
U.S.A.	Pergamon Press Inc., Maxwell House, Fairview Park, Elmsford, New York 10523, U.S.A.
CANADA	Pergamon Press Canada Ltd., Suite 104 150 Consumers Rd, Willowdale, Ontario M2J 1P9, Canada
AUSTRALIA	Pergamon Press (Aust.) Pty. Ltd., P.O. Box 544, Potts Point, N.S.W. 2011, Australia
FRANCE	Pergamon Press SARL, 24 rue des Ecoles, 75240 Paris, Cedex 05, France
FEDERAL REPUBLIC OF GERMANY	Pergamon Press GmbH, 6242 Kronberg-Taunus, Hammerweg 6, Federal Republic of Germany

---

Copyright © 1984 Pergamon Press Canada Ltd.

*All Rights Reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means: electronic, electrostatic, magnetic tape, mechanical, photocopying, recording or otherwise, without permission in writing from the copyright holders.*

First edition 1984

#### Canadian Cataloguing in Publication Data

Energex '84 (1984 : Regina, Sask.).

Energy developments : new forms, renewables,  
conservation

"Proceedings of ENERGEX '84, the Global Energy Forum,  
Regina, Saskatchewan, Canada, May 14-19, 1984." - cover.

Bibliography: p.

Includes index.

ISBN 0-08-025407-1

1. Energy development - Congresses. 2. Renewable  
energy sources - Congresses. 3. Energy conservation -  
Congresses. I. Curtis, Fred A. (Fred Allen), 1946-  
II. Title.

TJ163.15.E53 1984

333.79

C84-098747-1

*In order to make this volume available as economically and as rapidly as possible the authors' typescripts have been reproduced in their original forms. This method unfortunately has its typographical limitations but it is hoped that they in no way distract the reader.*



# **ENERGY DEVELOPMENTS: NEW FORMS, RENEWABLES, CONSERVATION**

---

**Proceedings of ENERGEX '84,**

**The Global Energy Forum,**

**Regina, Saskatchewan**

**Canada**

**May 14-19, 1984**

## PERGAMON PRESS

### Books of related Interest

BASU: Fluidized Bed Boilers: Design & Application

TAHER: Energy: A Global Outlook

WELDING INSTITUTE OF CANADA: Welding In Energy-Related Projects

GOURIERES: Wind Power Plants: Theory and Design

McVEIGH: Sun Power, 2/e

ZINBERG: Uncertain Power: The Struggle for a National Energy Policy

WORLD ENERGY CONFERENCE: Energy Terminology: A Multi-Lingual Glossary

PARKER: Energy Conservation Measures

YUAN: Energy, Resources & Environment

REIS: Economics & Management of Energy in Industry

### Journals of Related Interest

INTERNATIONAL JOURNAL OF HYDROGEN ENERGY

ENERGY CONVERSION & MANAGEMENT

SOLAR ENERGY

ANNALS OF NUCLEAR ENERGY

ENERGY DEVELOPMENTS IN JAPAN

### Electronic Databases

COMPENDEX

## CHAIRMAN'S FOREWORD

The theme of ENERGETEX '84 is "The effective integration of energy into a national quest for energy self-reliance with considerations being given to the technical, economic, and human dimensions." It attempts to reach out to industrial representatives, researchers, and government officials from both developing and developed countries. ENERGETEX '84 is the Canadian international energy forum; the goal of which is to seek solutions to the complex global energy problems through the technical presentations, plenary sessions and the energy exposition. Through these integrated approaches it is hoped that opportunities are provided which will lead to mutually beneficial long term relations in both institutional and commercial joint ventures in applied energy technologies.

Canada has a major role to play in providing the prerequisites required by developing nations in order to achieve the effective use and integration of their natural energy resources. The ENERGETEX series of global energy forums is the international meeting place where Canada and other countries can discuss international cooperation and developmental assistance leading to the rational use of energy.

The international concerns on the technical, economic and human dimensions are reflected in the technical presentations where the concerns and latest strategies and developments are presented by representatives from 50 countries. The dinner discussions on "The Global Energy Debt - The Energy Crisis" and "The World Oil Outlook and the Impact of Inventory Changes" present an opportunity to examine the complex questions such as: Are the energy opportunities of today the disadvantages of tomorrow? Is energy a means to adapt to or a means to overcome an economic depression? What are the barriers to adaptation of innovative energy supply systems? How can the energy demands and needs of the developing world be implemented with minimal social and political changes?

On behalf of the Organizing Committee of ENERGETEX '84 and the University of Regina I wish to extend the warmest welcome and trust that your stay in Regina be a most pleasant one. I also wish to thank the various sponsors, the members of the International Organizing Committee in 100 countries, and the members of the International Steering Committee for their work and contribution. The cooperation extended to us by Canada's Trade Posts is greatly appreciated.

Peter J. Catania  
Chairman  
ENERGETEX '84

## EDITOR'S FOREWORD

Papers in this work were accepted on the recommendation of four referees who reviewed abstracts received after a Call For Papers for Energex '84. Energex '84 does not in any way warrant or guarantee the accuracy of information contained herein.

Authors prepared papers using Guidelines prepared by the editor. Most papers were lightly edited for clearer readability, understanding and organization; few papers were rewritten.

The papers in this work are organized to indicate the three major themes of the Conference: New Forms of Energy, Renewable Forms of Energy, and Energy Conservation. For technical sessions within each theme, a person(s) was asked to prepare an overview paper on new developments on a specified energy topic. These overviews are indicated as invited papers.

I am most grateful to a number of people who assisted me in preparing this work and ensuring its availability at the Conference. The referees, H.J. Brian Curran, Saskatchewan Power Corporation, Don Gayton, Saskatchewan Department of Agriculture, Jim Mozel, Faculty of Engineering, University of Regina, and Bev Robertson, Woods Robertson Associates, carefully read each abstract and made difficult decisions on paper acceptance. Only a limited number of papers could be accepted in this work because of prior arrangements with the publisher. Pat Bellamy worked diligently in typing a multitude of revisions to the papers. Dean Milton helped organize the Subject Index. Audrey Perra helped organize the Table of Contents and Author's Index. Don Crawley, Executive Vice President, Pergamon Press offered his continued support throughout the project. My wife, Eileen, and children, Jennifer and Jeffrey, contributed their patience and understanding for the many hours I spent on this project.

This work is dedicated to my mother who believes that a positive attitude is an essential ingredient for improved health and well-being.

Fred Curtis  
Technical Program and  
Publications Chairman  
ENERGEX '84

**ENERGEX '84  
EXECUTIVE COMMITTEE**

The Honourable Grant Devine	Premier Province of Saskatchewan
Dr. Lloyd Barber	President University of Regina
Dr. Peter Catania	Assistant Dean Faculty of Engineering University of Regina
Mr. Stuart Mann	Associate Vice-President Finance and Services University of Regina
Mr. Al D.D. McEwen	Director Trade & Community Relations Saskatchewan Region Department of Regional Industrial Expansion Government of Canada
His Worship Mayor Larry Schneider	Mayor City of Regina



**ENERGEX '84**  
**INTERNATIONAL STEERING COMMITTEE**

Mr. Daniel R.W. Faux (Africa)	Executive Secretariat Economic Community of West African States
Dr. Ali Sayigh (Arab Speaking Countries)	Manager Solar Energy Department Kuwait Institute of Scientific Research
Dr. Wolfgang Sassin (Europe)	Acting Director Energy Systems Group International Institute for Applied Systems Analysis
Dr. R.L. Datta (Asia)	Past President International Solar Energy Society
Dr. Japy Montenegro Malgalhaes, Jr. (South America)	International Assessor Ministerio das Minas e Energia, Brazil
Dr. Dennis O'Brien (U.S.A.)	Acting Deputy Assistant Secretary for International Energy Security Department of Energy

**ENERGEX '84**  
**CHAIRMEN**

Dr. Peter J. Catania	Chairman
Mr. Stuart Mann	Finance Chairman
Professor Fred Curtis	Technical Program and Publications Chairman
Mr. Lorne Pavelick	Public Relations and Promotions Chairman
Mr. Morris Happy	Travel and Accommodations Chairman
Mr. George Bourassa	Corporate Sponsors Chairman
Dr. Josie Catania	Canadian International Development Agency Delegates Chairman

**ENERGEX '84**  
**GOVERNMENT REPRESENTATIVES**

Mr. Etienne von Engelhardt	Trade Officer Department of Regional Industrial Expansion Government of Canada
Mr. Fred Heal	Special Projects Director Saskatchewan Economic Development and Trade Government of Saskatchewan
Dr. Alex J.Y. Guy	Deputy Minister Department of Science and Technology Government of Saskatchewan
Ms. Diana Brown	Public Affairs City of Regina

**ENERGEX '84**  
**MAJOR SPONSORS**

City of Regina  
Government of Canada  
Government of Saskatchewan  
University of Regina

## ENERGEX '84 SPONSORS

Association of Canadian Studies  
Association of Consulting Engineers of Canada, Energy Secretariat  
Biomass Energy Institute  
Brace Research Institute  
Brown & Root Inc.  
Caltex Petroleum Corporation  
Canadian Association of Physicists  
Canadian Council of Professional Engineers  
Canadian Gas Association  
Canadian General Standards Board  
Canadian Home Insulators Contractors Association  
Canadian Manufacturers Association  
Canadian Petroleum Association  
Canadian Solar Industries Association  
Canertech Inc.  
Centre for Energy and Environmental Research, Puerto Rico  
Ceylon Institute of Scientific and Industrial Research, Sri Lanka  
Chemical Institute of Canada  
Comision Nacional de Investigaciones Especiales, Argentina  
Dhaka University, Bangladesh  
Economic Community of West African States  
Financial Times, Business Information Ltd.  
Geothermal Energy  
Housing and Urban Development Association of Canada  
Independent Petroleum Association of Canada  
Institut de Mecanique, Belgium  
Instituto Centroamericano de Investigacion Tecnologia Industrial,  
Guatemala  
Instituto Nacional de Fomento Cooperative, Costa Rica  
Kuwait Institute for Scientific Research, Kuwait  
Laboratorio Nacional Engenharia Tecnologia Industrial, Portugal  
Regina Chamber of Commerce  
Renewable Energy News  
Saskatchewan Association of Architects  
Saskatchewan Chamber of Commerce  
Saskatchewan Society of Manufactures Engineers  
Tata Energy Research Institute, India  
The Coal Association of Canada  
Universidad Nacional de Colombia, Colombia  
Universidad Tecnica Federico Santa Maria, Chile  
University of Singapore, Singapore  
University of Stirling, Scotland  
University of West Indies, Trinidad

## INTERNATIONAL ORGANIZING COMMITTEE

- ALGERIA**, Dr. M. Bouhadeff  
Station d'Experimentation Solaire
- ANGUILLA**, Mr. R.V.C. Hodge  
Accountant General  
Treasury Department
- ARGENTINA**, Ing. A.T. Rapallini  
Jafe Grupo Energia No Convencional  
Comision Nacional de Investigaciones  
Espaciales
- AUSTRALIA**, Mr. R. Hopkins  
Research Policy and Programs Branch  
Department of Resources and Energy
- AUSTRIA**, Dr. L. Schrattenholzer  
International Institute for Applied  
Systems Analysis
- BANGLADESH**, Mr. Ahmed Al Saroug  
Assistant Advisor  
Science and Technology Division
- BARBADOS**, Mr. I.W. Lashley  
Management Counsellor  
Barbados Institute of Management  
and Productivity
- BELGIUM**, Prof. Ing. L. Delvaux  
Laboratoire de Genie Chimique  
Institut de Mecanique
- BOLIVIA**, Prof. M.A. Ramierez  
Universidad Boliviana, Instituto de  
Investigaciones Fisicas
- BOTSWANA**, Mr. D. Medford  
Botswana Technology Centre
- BRAZIL**, Dr. J. Goldemberg  
President, Companhia Energetica  
de Sao Paulo
- BRITISH VIRGIN ISLANDS**,  
Mr. R.J. Arnott  
General Manager,  
British Virgin Islands  
Electricity Corporation
- BURUNDI**, Mr. J.P. Trussart  
Project Manager  
Centre d'Etude Burundais  
en Energies Alternatives
- CAMEROON**, Mr. M. Tomdito  
University Centre of Douala
- CHILE**, Dr. P. Sariato M.  
Universidad Técnica Federico  
Santa Maria
- COLOMBIA**, Prof. H. Pinzon-Isaza  
Universidad Nacional de Columbia
- COMMONWEALTH OF DOMINICA**,  
Mr. S.A.W. Boyd, Secretary  
Dominica Christian Council
- COSTA RICA**, Mr. R.A. Rojas  
Executive Director  
Institut Nacional de Fomento  
Cooperativ
- CYPRUS**, I. Papadopoulos  
Ministry of Commerce and Industry
- ECUADOR**, Ing. R.R. Maldonado  
Institute Nacional de Energia
- EGYPT**, Dr. H. Mohamed Ali  
National Research Centre
- ENGLAND**, June Morton  
Administrator  
UK-ISES
- ETHIOPIA**, Mr. Woldgiorghis  
Executive Secretary  
Ethiopian Energy Commission
- FIJI**, Mr. T. Scanlan  
Energy Officer, South Pacific  
Bureau for Economic Co-operation
- FINLAND**, Dr. Tor Stubb  
Ekono Oy
- FRANCE**, Mr. Ruth Roux  
Agence Francaise Pour La Maitrise  
De L'Energie
- GAMBIA**, Mr. M.M. Sahor  
Director, Water Resources
- GERMAN DEMOCRATIC  
REPUBLIC**, Dr. Hans-Jurgen Piprek  
Abteilungsleiter, Abteilung  
Interanationale Zusammenarbeit  
Ministerium Fur Kohla und Energie

- GUATEMALA, Mr. R. de Leon**  
Instituto Centroamericano de  
Investigacion y Tecnologia Industrial
- GUYANA, Mr. N.B. Barnwell**  
Engineering Manager  
Guyana Electricity Corporation
- GHANA, Mr. E. Appiah Korang**  
Office of Petroleum Dept.  
Ministry of Fuel and Power
- HAITI, Mr. P. Saint-Albin**  
Planificateur de L'Energie  
Ministère du Plan
- HONG KONG, Dr. Wong Ming Hung**  
Dept. of Biology  
The Chinese University of Hong Kong
- HUNGARY, Dr. T. Jaszay**  
Deputy Director, Institute for  
Engineering, Thermodynamics and  
Energy Systems, Technical University  
of Budapest
- ICELAND, Dr. I.B. Fridliefsson**  
UUN Coordinator  
Geothermal Division
- INDIA, Mr. C.R. Das**  
Co-ordinator, Tata Research Institute
- INDONESIA, Dr. Ketut Kontra**  
Director of Planning  
State Electricity Enterprise
- IRAN, Dr. M. Yaghoubi**  
Mechanical Engineering Department  
Shiraz University
- IRAQ, Dr. N. Al-Hamdani**  
Director General of Solar Energy  
Research Center, Council of Science
- IRELAND, Mr. J. Owen Lewis**  
School of Architecture  
University of College Dublin
- JAMAICA, Mr. H.I.C. Lowe**  
Energy Division  
Ministry of Mining and Natural  
Resources
- JAPAN, Dr. T. Noguchi**  
Chief, Solar Research Laboratory  
Government Industrial Research  
Institute
- JORDAN, Dr. A. Butros**  
Director General  
Royal Scientific Society
- KENYA, Prof. F.N. Onyango**  
Dept. of Physics,  
University of Nairobi
- KUWAIT, Dr. A. Bishara**  
Deputy Director General/Research  
Kuwait Institute for Scientific Research
- LESOTHO, Mr. T. Motsopa**  
Deputy Permanent Secretary  
Ministry of Water, Energy and Mining
- LIBYA, Dr. M.M. Ramadan**  
El Fateh University
- LIBERIA, Dr. Miedi-Himie Neufville**  
Director of the Bureau of Hydrocarbons  
Ministry of Lands and Mines
- MALAYSIA, Mr. N.J. Monerasinghe**  
Faculty of Housing, Building and  
Planning, University of Science  
Malaysia
- MALI, Dr. M.C. Traore**  
Director, Solar Energy Laboratory
- MAURITIUS, Mr. H.C. Rughooputh**  
School of Industrial Technology  
University of Mauritius
- MEXICO, Dr. L. Enrique Sansores**  
Jefe del Departamento de Energia Solar  
Instituto de Investigaciones en  
Materiales
- MOROCCO, Mr. Ahmed Bouhouli**  
Directeur de l'Energie  
au Ministere de l'Energie et des Mines
- NEPAL, Dr. K.L. Shrestha**  
Executive Director  
Tribhavan University
- NETHERLANDS, Dr. K. Joon**  
Netherlands Energy Research  
Foundation
- NEW CALEDONIA, Mr. G.L. Chan**  
Saipan Northern Mavano Islands
- NEW ZEALAND, Dr. T. Haskell**  
Department of Scientific and  
Industrial Research

- NIGERIA**, Dr. N.I. Ngoka  
Thermal and Passive Energy  
Laboratory
- PAKISTAN**, Dr. I.H. Shah  
Director Research  
N.W.F.P. University of Engineering  
and Technology
- PANAMA**, Mr. J.E. Monge  
Director, Energy Division  
Ministry Mines and Energy
- PARAGUAY**, Mr. J. Martino  
Director, Instituto Nacional de  
Tecnología y Normalización
- PERU**, Mr. A. Pons Muzzo  
Chairman, Corporation de  
Ingeniería Civil
- PHILIPPINES**, Mr. F.L. Santos Jr.  
Development Coordinator  
San Miguel Corporation
- POLAND**, Mr. J. Mozer  
Chief Specialist  
Ministry of Mining and Energy
- PORTUGAL**, Dr. M. Collares Pereira  
Departamento De Energias Reovaveis
- PUERTO RICO**, Mr. J.A. Bonnet Jr.  
Director, Centre for Energy and  
Environment Research
- SAMOA**, Dr. F.S. Wendt  
Dean of Campus  
University of the South Pacific
- SAUDI ARABIA**, Dr. R.M.S. Obaid  
Executive Director and Chairman of  
the Board, Saudi Arabian National  
Centre for Science and Technology
- SCOTLAND**, Dr. J.K. Jacques  
Department of Management Science  
University of Stirling
- SEYCHELLES**, Mr. S. Gendron  
Chief Research & Development Officer  
for Principal Secretary (Planning)
- SIERRA LEONE**, Dr. M. Whitfield  
University of Sierra Leone
- SINGAPORE**, Dr. B.B.P. Lim  
Dean, Faculty of Architecture and  
Building, University of Singapore
- SOUTH KOREA**, Dr. P. Chungmoo Auh  
Korea Institute of Energy  
and Resources
- SRI LANKA**, Dr. S. Gnanalingam  
Head, Section of Applied Physics  
and Electronics, Ceylon Institute  
of Scientific and Industrial Research
- ST. LUCIA**, Mr. H.H. Lubin  
Ministry of Agriculture, Lands,  
Fisheries and Co-operatives
- SUDAN**, Dr. A.A.R. El Agib  
Head, Sudanese Research Centre
- SURINAME**, Mr. W. Kong Tse Lam  
Buro of Hydropower, Ministry of  
Development of Suriname
- SWAZILAND**, Mr. P.K. Lukhele  
Chief Project Co-ordinator  
Ministry of Agriculture and  
Co-operatives
- SWEDEN**, Mr. E. Gabrielsson  
Erik Gabrielsson Ingenjorsbyrå
- SWITZERLAND**, Prof. M. Gratzel  
Ecole Polytechnique Federale  
de Lausanne
- SYRIA**, Eng. H. Safadi  
Ministry of Electricity
- TANZANIA**, Mr. A.A. Sissya  
Ministry of Water and Energy
- THAILAND**, Mr. T. Sirivadhanakul  
Regulatory Division  
National Energy Administration
- TOGO**, Mr. A.B. Baba-Moussa  
President de la Banque  
Quest Africaine de Developpement  
Mr. Abdoa Gafaron Osseni  
Directeur de l'Hydraulique et  
de l'Energie
- TRINIDAD**, Dr. S. Satcunanathan  
Head, Department of Mechanical  
Engineering, University of the  
West Indies
- TUNIS**, Mr. M. Maleij  
Faculty of Sciences of Tunis
- TURKEY**, Mr. A.G. Maddogan  
Enerji Dairesi Baskani  
Enerji ve Tabii Kaynaklar

**URUGUAY, Mr. Ponciano, J. Torrado**  
Secretario Academico,  
Facultad de Ingenieria,  
Universidad de la Republica

**U.S.A., Mr. T. Williams**  
Chief, Integrated Energy Systems  
Branch, Office of Industrial Programs

**U.S.S.R., Mr. M.A. Styikovich**  
Member, Academy of Sciences of  
the U.S.S.R.

**YUGOSLAVIA, Dr. P. Novak,**  
Univerza Edvarda Kardelja v Ljubljani

**ZAMBIA, Dr. F.D. Yamba**  
The University of Zambia

## TABLE OF CONTENTS

Chairman's Foreword	xv
Editor's Foreword	xvi
Executive Committee	xvii
International Steering Committee	xviii
Chairmen	xviii
Government Representatives	xviii
Major Sponsors	xix
Sponsors	xix
International Organizing Committee	xx
	xxi

## NEW FORMS OF ENERGY

### COAL GASIFICATION AND LIQUEFACTION

A Mechanistic Model for Combustion at the Cavity Wall during Underground Coal Gasification <i>J.G.M. Massaquoi</i>	5
The Feasibility of Coal Gasification <i>P.R. Schwarze</i>	15
Recent Developments of the LSE Process for Producing Gasoline from Coal and Lignite <i>G.G. Thurlow, D.F. Williams</i>	19
Approach to Direct Liquefaction of High Ash Low Rank Coals <i>J.A. Mikhlin</i>	25
Methane Gas from Underground Coal Mines: A Clean Source of Energy <i>V.J. Hucka</i>	31

### HEAVY OIL RECOVERY

Residual Oil in Reservoirs - Problems and Prospects <i>K.N. Jha, B. Hlavacek</i>	41
Alternatives for Heavy Oil Utilization through Fuller Integration of Upgrading and Refining <i>A.J. Orlickas, P.A. Rubero</i>	49
Dynamic Analysis of Sucker Rod Pumping <i>T.H. Nicol, J.C. Purcupile</i>	55
Small Scale Heavy Oil Upgraders on Saskatchewan Heavy Oil Fields <i>R.H. Shannon</i>	59
Comparison of Enriched Air and Normal Air In Situ Combustion <i>R.G. Moore, D.W. Bennion, J.P. Millour</i>	65
Monte Carlo Simulation and Heavy Oil Recovery Economics <i>R.E. Terry, D.L. Whitman, J.B. Page</i>	71

### OIL SANDS AND SHALES

Major Tar Sand and Heavy Oil Deposits of the United States <i>E. Hammershaimb, V.A. Kuuskraa, M.J. Paque</i>	77
U.S. Tar Sand Oil Recovery Projects - 1984 <i>L.C. Marchant and R.E. Terry</i>	85
Advances in In-Situ Oil Sands and Heavy Oil Recovery in Western Canada <i>W.K. Good, R.W. Luhning</i>	99
The Impact of Oil Sands Derived Synthetic Crude on Conventional Refineries <i>C.K. Yeung, A. Ledas, G.D. Kreissler</i>	105



Use of Critical Surface Tension of Wetting in the Beneficiation of Oil Shales	
<i>B. Yarar, G. Hemphill</i>	111
Oil Shales of Nova Scotia	
<i>M.C. Rochwell, S.R. Munroe</i>	117

## **TIDAL POWER, OCEAN POWER, WAVE POWER**

Tidal Power on Demand	
<i>E. van Walsum</i>	125
Economics of Tidal Plants Calls for Innovation in Technical Fields	
<i>M. Paccard</i>	131
The Sea-Clam Wave Energy Converter	
<i>A.M. Peatfield, L.J. Duckers, F.P. Lockett,</i>	
<i>B.W. Loughridge, M.J. West, P.R.S. White</i>	137
Electric Power from Salinity Gradients by Reverse Electrodialysis	
<i>S. Visaisouk, B.D. Turnham, R.N. O'Brien</i>	143
The Canadian Vertical Axis Hydro Turbine Program "Tidal Application"	
<i>D.H. Swan, B.V. Davis</i>	147

## **RENEWABLE FORMS OF ENERGY**

### **ACTIVE SOLAR SYSTEMS**

#### **(SIMULATION, MEASUREMENT AND EVALUATION)**

Irish Participation in the European Commission's Solar Pilot Test Facility Project	
<i>I.J. Cowan</i>	157
Scientific Monitoring Techniques for Evaluating the Performance of Solar Hot Water Heating Systems	
<i>J.E. Kaye, A.J. Zaidi, J.M. Nostedt</i>	163
Transient Simulation of a Solar Receiver under a Concentrated Solar Flux	
<i>M.M.S. Ahmed</i>	169
Including the Distribution of the Diffuse Component of Sky Radiation in Solar Simulator Testing	
<i>F.C. Hooper, A.P. Brunger</i>	175
Indoor Transient Tests on Solar Collectors	
<i>N.E. Wijesundera, M.N.A. Hawlader</i>	181
Performance Evaluation of Three Solar Hot Water Heating Systems in Canada	
<i>A.J. Zaidi, J.E. Kaye, J.M. Nostedt</i>	187
Performance Evaluation of A Refrigerant-Charged Solar Collector	
<i>W.A. Kamal</i>	193
Potential of Solar Hot Water Heating Systems at Higher Latitude Locations	
<i>G.S. Saluja</i>	199

### **BIOMASS ENERGY**

Economic Evaluations of Biomass Plantations	
<i>C.H. Strauss, P.R. Blankenhorn, T.W. Bowersox, S.C. Grado</i>	205
Genetically Improved Hardwoods as a Potential Energy Source in Ontario	
<i>H.W. Anderson, L. Zsuffa</i>	211
Energy Potential of Aspen and Other Hardwoods in the Prairie Provinces of Canada	
<i>T. Singh, M.M. Micko</i>	215