ENERGY DEVELOPMENTS:
NEW FORMS, RENEWABLES, CONSERVATION

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

Pergamon Press
Toronto • Oxford • New York • Sydney • Paris • Frankfurt
# TABLE OF CONTENTS

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

## NEW FORMS OF ENERGY

### COAL GASIFICATION AND LIQUEFACTION

A Mechanistic Model for Combustion at the Cavity Wall during Underground Coal Gasification

*J.G.M. Massaquoi*  
5

The Feasibility of Coal Gasification

*P.R. Schwarze*  
15

Recent Developments of the LSE Process for Producing Gasoline from Coal and Lignite

*G.G. Thurlow, D.F. Williams*  
19

Approach to Direct Liquefaction of High Ash Low Rank Coals

*J.A. Mikhlin*  
25

Methane Gas from Underground Coal Mines: A Clean Source of Energy

*V.J. Hucka*  
31

### HEAVY OIL RECOVERY

Residual Oil in Reservoirs - Problems and Prospects

*K.N. Jha, B. Hlavacek*  
41

Alternatives for Heavy Oil Utilization through Fuller Integration of Upgrading and Refining

*A.J. Orlickas, P.A. Rubero*  
49

Dynamic Analysis of Sucker Rod Pumping

*T.H. Nicol, J.C. Purcupile*  
55

Small Scale Heavy Oil Upgraders on Saskatchewan Heavy Oil Fields

*R.H. Shannon*  
59

Comparison of Enriched Air and Normal Air In Situ Combustion

*R.G. Moore, D.W. Bennion, J.P. Millour*  
65

Monte Carlo Simulation and Heavy Oil Recovery Economics

*R.E. Terry, D.L. Whitman, J.B. Page*  
71

### OIL SANDS AND SHALES

Major Tar Sand and Heavy Oil Deposits of the United States

*E. Hammershaimb, V.A. Kuuskraa, M.J. Paque*  
77

U.S. Tar Sand Oil Recovery Projects - 1984

*L.C. Marchant and R.E. Terry*  
85

Advances in In-Situ Oil Sands and Heavy Oil Recovery in Western Canada

*W.K. Good, R.W. Luhning*  
99

The Impact of Oil Sands Derived Synthetic Crude on Conventional Refineries

*C.K. Yeung, A. Ledas, G.D. Kreissler*  
105
Use of Critical Surface Tension of Wetting in the Beneficiation of Oil Shales
B. Yarar, G. Hemphill
Oil Shales of Nova Scotia
M.C. Rochwell, S.R. Munroe

TIDAL POWER, OCEAN POWER, WAVE POWER

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

RENEWABLE FORMS OF ENERGY

ACTIVE SOLAR SYSTEMS
(SIMULATION, MEASUREMENT AND EVALUATION)

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

BIOMASS ENERGY

Economic Evaluations of Biomass Plantations
C.H. Strauss, P.R. Blankenhorn, T.W. Bowersox, S.C. Grado
Genetically Improved Hardwoods as a Potential Energy Source in Ontario
H.W. Anderson, L. Zsuffa
Energy Potential of Aspen and Other Hardwoods in the Prairie Provinces of Canada
T. Singh, M.M. Micko
Biomass (Bagasse) Savings through Energy Conservation in Sugar Factories
  C.E. Quevedo, J. Jasiewicz 219
Biogas Production and Utilization at Wastewater Treatment Plants
  T. Viraraghavan, A.A. Cocci, P.M. Reece, R.C. Landine 225
Mesophilic Anaerobic Digestion of Screened Dairy Manure Using Conventional and Fixed-Film Reactors
  K.V. Lo, P.H. Liao 231
The Catalytic Effect of Copper (II), Zinc (II), and Nickel (II) on the Anaerobic Digestion of Salvinia Molesta (Mitchell)
  S.A. Abbasi, P.C. Nipaney 237

COOLING SYSTEMS
Passive Generation and Storage of Winter Ice for Summer Cooling Applications
  A.E. McGarity, A.I. Gorski 245
An Annual Storage Ice System for Cooling
  C.E. Francis 251
Design Optimization for a Solar Air-Conditioning System
  M. Kellow, D. Jarrar, G. Fadel 255

GEOTHERMAL ENERGY
Geothermal Energy in Canada - A Review of the Resources
  A.M. Jessop 263
Low Temperature Geothermal Energy in Canada
  R.J. Cousins, B.S. Larkin 267
An Assessment of the Low-Grade Geothermal Potential in a Foothills Area of West-Central Alberta
  H.L. Lam, F.W. Jones 273
  J.A. Majorowicz, F.W. Jones, H.L. Lam, A.M. Jessop 279
Assessment of the Geothermal Resources of Atlantic Canada
  M.J. Drury 285
Application of Existing Data to Low Temperature Geothermal Exploration
  H.A. Gorrell 291
Evaluating the Influence of Groundwater Flow Systems on Geothermal Conditions
  G. van der Kamp 297
Regina Geothermal Experiment - Geological and Hydrological Aspects
  L.W. Vigrass, A.M. Jessop 303
Modelling of the Regina Geothermal Aquifer
  K. Hutchence, L.W. Vigrass, A.G. Law, J.H. Weston 309
The Regina Geothermal Experiment - Thermal Aspects
  A.M. Jessop, L.W. Vigrass 315

HEAT PUMPS
Status of Heat Pump R & D
  J.T. McMullan 321
Recent Heat Pump Investigations for Northern Climate Applications
  C.E. Bullock, S.C. Pederson 325
Markets for Industrial Heat Recovery Heat Pumps in the UK: Myths and Realities
  S.D. Fawkes, J.K. Jacques 331
Implications of Oil-Refrigerant Interactions for Heat Pump Performance
  J.T. McMullan 337
INTERNATIONAL RENEWABLE ENERGY DEVELOPMENTS AND EXPERIENCES

An Overview on Renewable Forms of Energy for the Developing Countries
  N.I. Ngoka 345

An Overview of New Developments in Renewable Energy Sources
  F.N. Onyango 357

Status of Renewable Energy Programs in Caribbean Islands
  J.A. Bonnet, W.C. Koehler Jr. 363

IVES: A Concept of Rural Energy Development
  D.B. Waddle 373

Establishment of Design Criterion for Efficient Charcoal Stoves and Improved Kilns
  F.D. Yamba 377

METEOROLOGY AND SOLAR RADIATION

Prediction of Atmospheric Parameters for Spectral and Total Solar Irradiances
  H.M. Shafey 387

Improved Estimation of Solar Irradiation From Sunshine Duration Using Meteorological Constraints
  M. Hussain 393

Global Longwave Radiation at Edmonton, Alberta
  G.W. Sadler 397

PASSIVE SOLAR BUILDING DESIGN AND EVALUATION

Overview of Passive Solar Technology
  P.C. Auh, W. Park 405

Energy Conservation of Buildings in the Hot Humid Climate - An Overview
  B.B.P. Lim 411

Evaluation of Passive Solar Cooling or Heating for Different Building Forms
  B. Soliman 417

Evaluation of Some Passive Methods for Summer Conditioning of Residential Buildings by Analogue Method
  G. Singh, J.K. Sharma 421

Thermal Behaviour of Buildings Subjected to High Fenestration
  P.C. Philipp, V.P. Nicolau, F.O. Ruttkay Pereira 427

Energy Conservation Possibilities Through Building Design and Passive Cooling Techniques in Warm Climates
  K.R. Rao 433

Design and Evaluation of a Solar Wall for a Farm Building
  J. Paris, A. Dandurand, C. Davidson, D. Leblanc 441

PASSIVE SOLAR SYSTEMS (SIMULATION, MEASUREMENT AND EVALUATION)

Computer Simulation and Thermal Measurements of Roofs
  G.B. Hanna, M.H. Khalil 451

Thermal Environmental Control of Buildings and ‘Temper’
  N.K. Garg, M.J. Wooldridge, J. Longmore 457

Algorithm for Direct Gain Rooms and Sensitivity Analysis
  A. Athienitis, H.F. Sullivan, K.G.T. Hollands 463

Chameleon Fassade
  O. Haas, P. Kesselring 469

vii
PHOTOVOLTAICS

Thermal and Electrical Behaviour of Multistage Photovoltaic Concentrators

B.M. Hachem

Photoelectrochemical Solar Cells (PESC) Using Li Doped CdS Semiconductor Photoanodes Obtained by Chemical Bath Deposition

S. Chandra, S.N. Sahu

Solarvilla - A Demonstration Project Utilizing Solar Photovoltaic Energy for Housing in Remote Areas in Saudi Arabia

E.N. Ali Oglu

SOLAR HEATING AND STORAGE SYSTEMS

A Domestic Water Heating System with a Self-Controlling Downwards Heat Transport Device

V. Tacchi, R. Tacchi, A. Rapallini

Experimental Study of the Thermosyphonic and Built-In-Storage Type Solar Water Heaters

T. Muneer, M.M. Hawas

Stratification in Solar Domestic Hot Water Storage Tanks

W. Dobbin

Thermal Diffusivity in a Stratified Storage Tank

A. Palacio P., A. Rodriguez V.

Low Temperature Energy Storage in Calcium Chloride Hexahydrate

J.C. O'C. Young, J.A. Collicutt

Materials for Latent Heat Storage at 573 K

B.S. Magal, H.D. Bhargava, A. Purushothaman, S.P. Pathak

Comparison of Solar-Thermal Energy Storage Performance of Certain Liquid Oils with Pressurized Liquid Water

M.E. Talaat

Efficiency of Water Thermal Storage

P. Novak, S. Medved

Performance of Integrated Rock Bed Solar Air Heater

H.P. Garg, V.K. Sharma

SOLAR PONDS

Thermal Analysis of a Small-Scale Solar Pond with a Planar Reflector

W.A. Kamal, M.A. Hassab

Solar Ponds: Applications in Northern Climates

D. Crevier

Performance of a Model Shallow Salt Gradient Solar Pond

P.C. Lobo, L.U. de Araujo

SOLAR SYSTEMS APPLICATIONS

Experience from Three Full Scale Solar Heating Plants with Seasonal Storage

E. Gabrielsson

A Performance Study of Solar Stills

K.C. Ng, M.N.A. Hawlader

A Study of a Solar-Magnetohydrodynamic Power Cycle

J.L. Hernandez S.

Standardization in Solar Energy Thermal Applications

P. Novak

State-of-the-Art of Solar Thermal Industrial Process Heat Technologies for Use in Developing Countries

P.G. Patil, A. Srivastava

Solar Furnace for Small Scale Metallurgical Applications

K.R. Gopalakrishna, S. Seshan
SOLAR SYSTEMS COMPONENTS AND MATERIALS

The Hyperbolic Tube in Solar Collectors
  O.M. Tapia
  597
Axially Grooved Gravity Assisted Heat Pipe for Thermal Energy Recovery Systems
  G. Singh, R.G. Tathgir
  603
Experimental and Theoretical Analysis of an Evacuated Tube-Plate Collector Glazed with Assembled Compound Parabolic Concentrators
  Z.Y. Chan, C.Q. Wang, J.C. Zhang
  609
Further Study of Thermal Constriction Resistance at the Interface of Double-Tubes
  J.C.Y. Wang, E.S. Nowak
  613
Investigation of Nucleate Boiling Heat Transfer on Sintered Porous Surfaces for a Binary Cycle Exchanger
  Z. Guili, L. Ruitai
  619
Design and Development of a Novel Fixed Mirror Solar Concentrator
  V. Balasubramanian, G. Sankarasubramanian, H.S. Kedlaya, G. Swarup
  625

WIND ENERGY

A Microprocessor-Controlled Windmill Simulator
  J. Le-Huy, J. Anderson, P. Viarouge, J.M. Vesin
  633
Control Schemes for Darrieus Wind Turbines
  G.-E. April, G. Olivier, R.P. Bouchard
  639
Performance and Operational Testing of the Swift Current 50 KW Vertical Axis Wind Turbine
  D.W. Campbell, P.W. Davall
  645
Economic Modelling of WECS Installations
  J.T. Edworthy
  651
An Approach to Wind Energy Operated Irrigation System
  V.J. Modi, M.S.U.K. Fernando, N.J. Roth
  655
Home Energy Management with Wind Power
  C.E. Sivers
  661
New Method to Harness More Wind Energy
  A. Jagadeesh, N.C. Varshneya
  663

ENERGY CONSERVATION

ENERGY CONSERVATION IN AGRICULTURE

Energy Integrated Farm System (EIFS)
  O.P. Hall, Jr.
  673
The Energetics of Canadian Prairie Wheat Production 1948-1981
  G.R. Hopper
  677
The Impact of Alternate Export Scenarios on Energy Use in Saskatchewan - An Input-Output Approach
  B.W. Gould, S.N. Kulshreshtha, J. Sampson
  685
Optimization of Farm Field Operations
  R.J. Palmer
  691
An Assessment of Current Energy Use Levels and Conservation Practices on Saskatchewan Farms
  S.N. Kulshreshtha, B.W. Gould
  697
Energy Implications from Extending Wheat Rotations in the Brown Soil Zone of Western Canada
  R.P. Zentner, D.W. Campbell
  701
Energy Savings by Efficient Operation of Farm Tractors
  G.C. Zoerb, R.L. Kushwaha
  705
ENERGY CONSERVATION IN INSTITUTIONAL AND COMMERCIAL BUILDINGS

Energy Conservation for a Provincial Office Building
G.D. McKenzie 711

Energy Conservation in School Buildings and Its Financial Impact on Operating Expenses and on the Space's Physical Environment
J. Santos 715

How to Waste Energy Without Even Trying or an Easy Way to Conserve Energy in Ventilating Systems
O. Smolik, E. Stoyke 719

An Energy-Based Analysis of Interior Illumination Systems in Office Buildings
M. Siminovitch, W. Place 723

M.K. Benjamin 729

Building Energy Targeting
I.A. Jarvis 735

Energy Retrofitting: An Office Building Case Study
G.F. Bourassa, S.D. Phillips 741

ENERGY CONSERVATION IN RESIDENTIAL BUILDINGS

The Design of an Energy Efficient Residential Building Standard for Northern Canada
R. Bushey 749

Energy Conservation in Rural Dwellings
C. Testa 753

Development of Header Insulation
J.A. Hudson 757

Cranbrook Residential Energy Survey
R. Careless 763

ENERGY ECONOMICS

An Assessment of the Market Potential and Economic Impacts of Energy Conservation in the Canadian Residential/Commercial/Industrial Sectors
L.D.R. Dyke, W.S. Chan 769

Shared Savings Financing for Energy Efficiency: Feasible but Complex
P. Benjamin 777

Time-of-Use Rates and Load Management in the Water Industry: Cost Savings or Energy Conservation?
W.H. Sang 783

House Heat Supply Functions
G. Capper, A. Scott 789

Potential for Interfuel Substitution in Canada
B.C. Sumner 795

ENERGY EFFICIENT LAND USE PLANNING

Passive Solar Urban Planning - A Cellular Technique
V. Matus 803

A Strategy for Energy Efficient Residential Land Use: City of Lethbridge Case Study
R. Southwell, L. Lange 809

Energy Conservation Opportunities in Ontario Legislation for Residential Project Planning
A.J. Richardson, F.A. Curtis 815
Energy Use and Land-Use Patterns in the City
  G. Armen 819
Solar Access Law in Canada
  M.A. Bowden 827

ENGINE AND FUEL SYSTEMS

The Production of Distilled Water Using Waste Heat from the Jacket-Cooling Water of Diesel Engines
  B.W. Tleimat 835
Thermostatically-Controlled Engine Block Heaters for Energy Conservation and Load Management
  M. Sulatisky, R. Graham 841
Scope of Fuel Conservation in Agriculture Sector in India
Computer Control in Spark Ignition Engines
  H.P. Fagerstrom 853
Boiler Fuel Savings by Heat Recovery and Reduced Standby Losses
  B.M. Gibbs 859
Sime Power Engine
  J. Gu, Z. Chen 865

GOVERNMENT ENERGY CONSERVATION INCENTIVE PROGRAM

The Institutional Conservation Program: A Success Story
  K.G. Johnson 871
Energy Conservation: Canadian Department of External Affairs
  J.W. McKay 879
Changing Incentives for Municipal Energy Conservation: New Directions
  J. Lounds 885
Consumer Information, Government Incentive Programs, and the Residential Retrofit Decision
  R.A. Douthitt, G.M. Moss 889
“Don’t Pay for Insulation...Buy Conservation!” Implementing a RECAP, The Next Step in Residential Conservation
  R.E. Esteves 897
Cranbrook Community Energy Audit
  R. Careless 903
Energy Conservation for Developing Countries
The Canadian Conservation and Alternative Energy Demonstration Programs
  L.G. Tremblay 913
Manitoba’s Energy Efficient Housing
  W.M. McDonald 917
Canada - New Brunswick Conservation and Renewable Energy Demonstration Agreement
  M.J. Robichaud 921
Retrofitting - A Yukon Approach
  R.E. Collins 923

INDUSTRIAL ENERGY CONSERVATION MANAGEMENT AND PROGRAMS

Industrial Energy Management: The Potential for Government and Consultancy - Current Mismatches and Future Opportunities
  J.K. Jacques 929