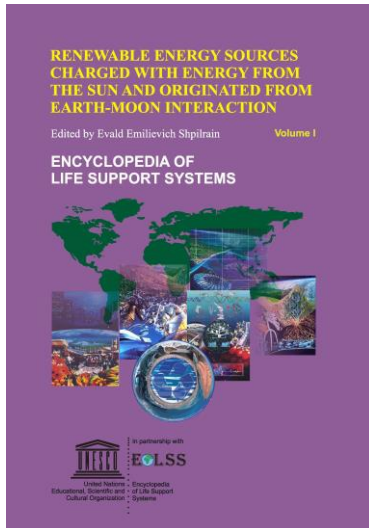


# CONTENTS

## RENEWABLE ENERGY SOURCES CHARGED WITH ENERGY FROM THE SUN AND ORIGINATED FROM EARTH-MOON INTERACTION



**Renewable Energy Sources Charged With Energy from the Sun and Originated from Earth-Moon Interaction Volume 1**  
e-ISBN: 978-1-84826-019-1  
ISBN : 978-1-84826-469-4  
No. of Pages: 356

**Renewable Energy Sources Charged With Energy from the Sun and Originated from Earth-Moon Interaction Volume 2**  
e-ISBN: 978-1-84826-020-7  
ISBN : 978-1-84826-470-0  
No. of Pages: 270

For more information of e-book and Print Volume(s) order, [please click here](#)

Or contact : [eolssunesco@gmail.com](mailto:eolssunesco@gmail.com)

## CONTENTS

### VOLUME I

#### **Renewable Energy Sources Charged with Energy from the Sun and Originated from Earth-Moon Interaction** **1**

Evald E. Shpilrain, *Institute for High Temperatures, Russian Academy of Sciences, Moscow, Russia*

1. Introduction
2. Biomass as an Energy Source
  - 2.1. Biomass Origin
  - 2.2. Use of Biomass Energy
    - 2.2.1. Thermochemical Conversion
    - 2.2.2. Biochemical Conversion
3. Wind Energy
  - 3.1. Wind Origin
  - 3.2. Wind Characteristics
  - 3.3. Use of Wind Energy
  - 3.4. Wind Energy Conversion Systems
  - 3.5. Environmental Issues of Wind Energy Use
  - 3.6. Economics of Wind Energy
4. Wave Energy
  - 4.1. Wave Characteristics
  - 4.2. Use of Wave Energy
  - 4.3. Environmental Implications of Wave Energy Use
  - 4.4. Wave Energy Economics
5. Temperature Differences in the Ocean and Between Ocean and Air as Energy Source
  - 5.1. Temperature Difference in the Ocean
    - 5.1.1. Use of Temperature Differences in the Ocean
  - 5.2. Air/Water Temperature Difference Utilization
  - 5.3. OTEC, AWTEC, and OTEC/DOWA Economics
  - 5.4. OTEC and OTEC/DOWA Interaction with the Environment
6. Tidal Energy
  - 6.1. Origin and Types of Tide
  - 6.2. Energy and Power of the Tide
  - 6.3. Tidal Power Plants
7. Conclusion

#### **Energy from Biomass**

**47**

Ralph P. Overend, *National Renewable Energy Laboratory, Golden, CO 80401, USA*

1. Biomass
  - 1.1. Photosynthesis and Biomass Yields
  - 1.2. Biomass Properties
    - 1.2.1. Polymeric and Chemical Composition
    - 1.2.2. Fuels Analysis
    - 1.2.3. Physical Properties
    - 1.2.4. Biomass Briquettes and Pellets
2. The Biomass and Bioenergy System
  - 2.1. Biomass is the World's Fourth Fuel
    - 2.1.1. Individual Country Usage
3. End-use Patterns of Biomass and Bioenergy Use
  - 3.1. Daily Living
    - 3.1.1. Efficiency of Small Scale Combustion
    - 3.1.2. Small Scale Space Heating

- 3.2. Community Systems - District Heating and Cooking Systems
  - 3.2.1. Biomass Fueled District Heating
  - 3.2.2. District Heating Using Biomass Fueled Combined Heat and Power (CHP) Plants
  - 3.2.3. Cooking Fuel Distribution Systems
- 3.3. Industrial Applications
  - 3.3.1. Small Industries, Commercial and Institutional Uses
  - 3.3.2. Combined Heat and Power (CHP) or Cogeneration
- 3.4. Environmental Technologies
  - 3.4.1. Anaerobic Digestion
  - 3.4.2. Commercial Technical Processes of Anaerobic Conversion of Residues
  - 3.4.3. Applications for Developing Countries
  - 3.4.4. Animal Residue Equivalents for a Given Output of Electricity
4. Biofuels
  - 4.1. Charcoal
    - 4.1.1. Charcoal Production Technology
  - 4.2. Liquid Fuels from Biomass
    - 4.2.1. Ethanol
    - 4.2.2. Cost and Scale Information
    - 4.2.3. Ethanol from Lignocellulosics
    - 4.2.4. Biodiesel
  - 4.3. Power Generation Technologies
    - 4.3.1. Cofiring
    - 4.3.2. Integrated Gasification Combined Cycle (IGCC)
    - 4.3.3. Lifecycle and Economic Aspects
5. Biomass Resources
  - 5.1. Biomass Energy in the Daily Living Sector
  - 5.2. Energy Plantations
    - 5.2.1. Species being considered for Energy
6. Conclusions

## Direct Combustion of Biomass

74

Ralph P. Overend, *National Renewable Energy Laboratory, Golden, Colorado, USA*

1. Background
2. Fundamentals of Biomass Combustion
  - 2.1. Efficiency Constraints in Combustion
3. The Nature of Biomass Solid Fuels
  - 3.1. Standard Tests in Fuels Analysis
  - 3.2. Proximate and Ultimate Analysis
4. Fuel Preparation
5. Combustion Products from Biomass
  - 5.1. Mineral Matter and Ash
  - 5.2. Nitrogen Oxides
  - 5.3. Sulfur Dioxide SO<sub>2</sub>
  - 5.4. Chlorine – tube corrosion and dioxin (TCDD) formation
6. Gaseous and Liquid Fuels Derived from Biomass
  - 6.1. Biogas
  - 6.2. Thermal Production of Low or Medium Value Calorific Gas
  - 6.3. Biomass derived gas combustion
7. Emissions Control
  - 7.1. Particulate control
8. Biomass Combustion Systems - Performance and Economics
  - 8.1. Space Heating
  - 8.2. Heat and Power Generation
  - 8.3. Trends in Heat, Power and Combined Heat and Power Production
9. Conclusions

## **Thermochemical Conversion of Biomass**

**101**

Ralph P. Overend, *National Renewable Energy Laboratory, Golden, Colorado, USA*

1. Introduction
2. Pyrolysis Fundamentals
  - 2.1. The Chemical Nature of Pyrolysis in the Solid and Gaseous States
  - 2.2. Thermal Aspects of Pyrolysis
3. Pyrolysis Process Technology
  - 3.1. Slow Pyrolysis
  - 3.2. Fast Pyrolysis
    - 3.2.1. Fast Pyrolysis Process Developments
    - 3.2.2. Bio-oils from Fast Pyrolysis. Properties and Applications
    - 3.2.3. Economics and Environment, Health and Safety (EH&S) of Bio-oils
4. Gasification Technologies
  - 4.1. Gasification Fundamentals
  - 4.2. Gasifier Systems
    - 4.2.1. The Counter Flow Moving Bed Gasifier (updraft)
    - 4.2.2. Fluidized Bed Gasifiers
    - 4.2.3. Entrained Flow Gasifiers
    - 4.2.4. Co-current Moving Bed Gasifiers (downdraft and cross draft units)
    - 4.2.5. Indirect gasifiers
    - 4.2.6. Black Liquor Gasification
  - 4.3. Applications of Gasification
    - 4.3.1. Power Systems
  - 4.4. Liquid Fuels and Chemicals Production
    - 4.4.1. Fischer-Tropsch Production of Hydrocarbon Liquid Fuels
    - 4.4.2. The production of Methanol and Higher Alcohols from Syngas
    - 4.4.3. DiMethyl Ether and Gasolines from Methanol
5. Conclusions

## **Wind Energy**

**127**

Vladimir A. Dobrovolski, *Director, Wind Energy Department of Moscow Aviation Institute (MAI), Director, Molinos Co. Ltd., Moscow, Russian Federation*

1. History of Wind Power Application
2. Wind Energy for Electrical Power Production
  - 2.1. Horizontal and Vertical Axis Wind Turbines
  - 2.2. Wind Machines Mode of Operation
3. Trends and Prospects of Wind Power Application for Vessels Propulsion.
  - 3.1. Flettner Rotor for Ship Propulsion
  - 3.2. Wind Power Driving the Ship Propelling Screws
4. Wind Turbine Technology
  - 4.1. Aerodynamics of the Wind Wheel
  - 4.2. Types of Electrical Generators Used With Wind Mills
  - 4.3. Wind Turbine Generator System Classes
  - 4.4. Control Systems
  - 4.5. Tower Type
  - 4.6. Power Transmission from Sea to Shore
  - 4.7. Stand-alone Systems
  - 4.8. Turbines for Water Heating
  - 4.9. Batteries
5. Hybrid Systems
6. Environmental Aspects
7. Legal Aspects
8. Economics of Wind Systems
9. International and National Activity

**General Characteristics and Meteorology of Wind**

**145**

Vladimir A. Dobrovolski, *Moscow Aviation Institute, Russian Federation*

1. Wind Distribution
2. Eolian Features
3. Biological Indicators
4. Anemometers
5. Wind Direction
6. Energy and Power of Wind
7. Wind energy classification
8. The Effect of Site Wind Characteristics on Energy Production of Wind Turbines
9. Wind Conditions
  - 9.1. Normal Wind Conditions.
  - 9.2. Extreme Wind Conditions
10. Siting for Wind Turbines
  - 10.1. Icing
  - 10.2. Abrasive Particles
  - 10.3. Corrosive Particles
  - 10.4. Electrical Effects

**Fundamentals of Energy Extraction from Wind**

**161**

Vladimir A. Dobrovolski, *Wind Energy Department of Moscow Aviation Institute (MAI), Director, Molinos Co.Ltd., Moscow, Russian Federation*

1. Introduction
2. Forces Arising when Wind Flows Over an Airfoil
3. Power Carried Over by the Wind and Extracted by the Wind Wheel
4. Types and Operating Characteristics of Wind Rotors
5. Wind Turbine Design and Output

**Wind Mills with Horizontal and Vertical Shaft**

**169**

Vladimir A. Dobrovolski, *Director, Wind Energy Department of Moscow Aviation Institute (MAI), Director, Molinos Co. Ltd., Moscow, Russia*

1. General Considerations
2. Development of Large Horizontal-Axis Systems
3. Development of Vertical-Axis Systems
4. Control Systems
5. Aerodynamics
6. Structural Dynamics
7. Fatigue and Failure Analysis

**Wind Installation for Water Pumping, Autonomous and Grid-Connected Power Production**

**176**

Vladimir A. Dobrovolski, *Director, Wind Energy Department of Moscow Aviation Institute (MAI), Director, Molinos Co. Ltd., Moscow, Russia*

1. Introduction
2. Agricultural Applications
3. Stand-alone and Wind/diesel Hybrid Systems
4. Water Pumping
  - 4.1. Matching of Wind Rotors and Pumps
  - 4.2. Future Potential of Wind powered Pumping
5. Wakes and Clusters
6. Siting Large Wind Machines

- 6.1. Wind Prospecting
- 6.2. Evaluation of a Predetermined Site
7. Siting Small Wind Machines
  - 7.1. Determining Feasibility
  - 7.2. Selecting Site and System

**Economics of Wind Installations** **187**

Vladimir A. Dobrovolski, *Director, Wind Energy Department of Moscow Aviation Institute (MAI), Director, Molinos Co. Ltd., Moscow, Russia*

1. General Considerations
2. Economics of Wind Energy for Utilities
3. Economics of Wind Energy for Small Applications

**Wind Installation and the Environment** **191**

Vladimir A. Dobrovolski, *Director, Wind Energy Department of Moscow Aviation Institute (MAI), Director, Molinos Co. Ltd., Moscow, Russia*

1. Introduction
2. Acoustics
3. Electromagnetic Interference
  - 3.1. Television
  - 3.2. AM Radio, FM Radio, TV Audio and Microwave Communication
  - 3.3. Aircraft Navigational Systems
4. Aesthetic
5. Land Use and Soil Disturbances
6. Biophysical
7. Environmental Conditions

**Natural Temperature Differences as an Energy Source** **197**

Michel A.P. Gauthier, *Acting Chairman of the International OTEC/DOWA Association, France*

1. Introduction
2. Temperature Differences in the Ocean and Between Air and Water.
3. Extracting Work from the Ocean Heat Reservoir
  - 3.1. OTEC Principle and Historical Background
  - 3.2. OTEC Technology Description
  - 3.3. Ocean Thermal Resource and OTEC Plants Sites
4. OTEC By-products and Deep Ocean Water Applications
5. Environmental Issues of the Exploitation of Ocean Thermal Energy
6. Ocean Thermal Energy: Costs and Economic Value
7. Ocean Thermal Energy Perspectives

**Temperature Differences in the Ocean at Low Latitude and Between Sea or River Water and Air at High Latitudes** **208**

Alexander A. Gorlov, *P.P. Shirshov Institute of Oceanology, Russian Academy of Sciences, Russia*

1. Thermal Energy Accumulation
  - 1.1. Types of Thermal Stratification
  - 1.2. Local Vertical Temperature Distribution in the Surface Layer
  - 1.3. Abyssal Circulation
2. Estimates of Ocean Thermal Energy Stocks
3. OTEC Using Industrial Water
4. Cold Deep Ocean Water Application

- 4.1. Air Conditioning
- 4.2. Refrigeration
5. Temperature Differences at High Latitudes
  - 5.1. Assessment of Arctic Ocean Thermal Resources
  - 5.2. Energy Resources of the Temperature Difference Between Surface and Deep Waters in Fjords
6. Temperature Differences Between Warm Ocean and Iceberg
7. Temperature Differences Between DOW and Hydrothermal Vents
  - 7.1. Temperature Difference Between Land Geothermal Sources and Ocean Waters
8. Conclusion

**Schemes and Cycles for Ocean Temperature Differences Utilization** **231**  
Louis A. Vega, *PICHTR, USA*

1. Background
2. Technical Limitations
3. OTEC and the Environment
4. Engineering Challenges
5. Open Cycle OTEC
6. The 210 kW OC-OTEC Experimental Apparatus
7. Design of a Small Land-Based OC-OTEC Plant
8. Closed Cycle OTEC
9. Design of a Pre-Commercial Floating Hybrid-OTEC Plant
10. Potential Sites
11. Economic Considerations and Market Potential
12. Hydrogen Production
13. Externalities

**Schemes and Cycles of Air/Water Temperature Differences Utilization** **252**  
Viacheslav A. Korobkov, *Baltic State Technical University, St. - Petersburg, Russia*  
Albert K. Ilyin, *Professor, Astrakhan State Technical University, Astrakhan, Russia*

1. Introduction
2. Classification of Converters
3. Main Schemes of Converters
4. Theoretical Aspects
5. Practical Aspects
6. Conclusion

**Economics of Natural Temperature Differences Utilization** **267**  
Donald Edward Lennard, *Ocean Thermal Energy Conversion Systems Limited, UK*

1. Basis of Assessment
2. Market
3. Opportunity
4. Status of Technology
5. Other Factors
6. Case Study
7. Conclusions and the Future

**Environmental Issues of Natural Temperature Differences Utilization** **281**  
Michel A.P. Gauthier, *The International OTEC/DOWA Association, France*

1. Review of the OTEC and AWTEC Potential Markets and Development Foresight
2. Review of the Main Environmental Characteristics of the Potential OTEC Plants Sites

3. Review of OTEC and AWTEC Plants Features of Main Concern for the Environment
4. Impacts of OTEC Facilities Water Discharges. Theoretical and Experimental Results
  - 4.1. A Study Case: the Tahiti 5 MW OTEC Project
  - 4.2. At Sea Experiment on Artificial Upwelling; the Japanese Ocean-based Toyama Facility
  - 4.3. Monitoring Waters Discharges at the NELHA Facilities
5. Conclusion

**Index** **295**

**About EOLSS** **301**

## VOLUME II

**Wave Energy** **1**

Vladimir I. Vissarionov, *Department of nontraditional and renewable energy sources, Moscow Power Engineering Institute (Technical University), Russia*

Valeri V. Volshanik, *Department of water power utilization, Moscow State University of Civil Engineering, Russia*

1. Waves Origin
2. Energy of Wind Waves
3. Methods of Wave Energy Extraction
4. Application of Wave Energy
5. Wave Energy Converters Classification
6. Conclusion

**Wave Motion Physics and Energy Potential** **15**

Nickolay K. Malinin, *Professor, Department of nontraditional and renewable energy sources, Moscow Power Engineering Institute (Technical University), Russia*

1. Introduction
2. Linear Wind Waves
3. Nonlinear Wind Waves
  - 3.1. Stocks Theory
  - 3.2. Theory of an Isolated Wave
4. Wave Energy Resources

**Principles of Wind Wave Energy Extraction** **30**

Valeri V. Volshanik, *Professor, Department of water power utilization, Moscow State University of Civil Engineering, Russia*

1. General Equations
2. Principles of Wave Energy Extraction
3. Principles of Design for Wave Energy Extraction
4. Types of Processes and Working Tools for Wave Energy Extraction
5. Detailed Analysis of Working Tools Design

**Proposed Systems for Wave Energy Conversion** **47**

Valeri V. Volshanik, *Professor, Department of water power utilization, Moscow State University of Civil Engineering, Russia*

1. General Considerations



2. Designs that Use Periodic Alteration of Water Level in a Point of a Relatively Stabilized Body
3. Designs that Use the Difference of Phases of Water Levels in Spatially Spread Points
4. Designs that Use the Phases of Hydrostatic Pressure Difference in Spatially Spread Points
5. Designs that Use the Phases Difference in Total Water Pressure in Spatially Spread Points
6. Designs that Use Alteration of Total Pressure along a Relatively Stabilized Body
7. Designs that Use the Slope of Wave Surface
8. Designs for Wave Energy Concentration
9. Designs Used for Conversion of Energy of Particles in a Wave
10. Conclusions

#### **Economics of Wave Power Production**

**64**

Valeri V. Volshanik, *Professor, Department of water power utilization, Moscow State University of Civil Engineering, Russia*

Nickolay K. Malinin, *Professor, Department of nontraditional and renewable energy sources, Moscow Power Engineering Institute (Technical University), Russia*

1. Economic Feasibility of Wave Power Devices
2. Ways of Improving Economic Feasibility of WPP Plants
3. Classification of Wave Power Devices by Consumers Requirements
4. Analysis of Comparative Economic Efficiency of Wave Power Devices.

#### **Environmental Aspects of Wave Power**

**77**

Lev A. Zolotov, *Professor, Department of nontraditional and renewable power sources, Moscow Power Engineering Institute (Technical University), Russia*

1. General Aspects
2. Wave Power Devices Environmental Features
3. Ways to Improve Wave Power Devices Friendliness
4. Conclusion

#### **Tidal Energy**

**83**

Igor N. Usachev, *Share -holding Company, Institute Hydroproject, Moscow, Russia*

1. Tidal Range
2. The Energy of Ocean Tides
3. Main Positive Features of Tidal Energy
4. Projects of TPP
5. Efficient Model of Tidal Energy Usage
6. Economical Methods of TPP Construction
7. Ecological Safety of TPP
8. First in the World Industrial TPP Rance in France
9. First in Russia Kislaya Guba TPP
10. Projects of Global TPP in Russia
11. Annapolis TPP and Projects of High-Capacity TPP in Fundy Gulf in Canada
12. Construction of TPP in China
13. TPP in Korea
14. Project of High-Capacity Severn TPP in England
15. Role of Tidal Energy in the World Energetics

#### **Characteristics of Tidal Energy**

**101**

Lev B. Bernshtein, *Share -holding Company, Institute Hydroproject, Moscow, Russia*

1. Tide Characteristics
2. Tidal Energy in the World Oceans and Balance of Tidal Energy
3. Energy Potential

4. Diurnal Irregularity of Tidal Energy
5. Inequalities within a Month of Tidal Energy
6. Invariability of Monthly Mean Tidal Ranges

#### **Historical Sketch, Perspective and Classification of TPP Schemes**

119

Lev B. Bernshtein, *Share - holding Company, Institute Hydroproject, Moscow, Russia*

1. Historical Perspective of Utilization of Tidal Power
2. Classifications and Comparison of TPP Schemes
  - 2.1. Single-pool Double-action Scheme
  - 2.2. Single-pool One-action Scheme
  - 2.3. Comparison of One- and Double-action Schemes.
  - 2.4. Comparison of the Single-pool Scheme with Multi-pool Schemes

#### **Specific Features of Tidal Power Plants**

135

Igor N. Usachev, *Share-holding Company, Institute Hydroproject, Moscow, Russia*

1. Specific Features of Site Selection
2. Specific Features of Determination of TPP Capacity and Output
3. Non-traditional Technologies of TPP Erection
4. Longevity of TPP Materials and Structures in Oceanic Environment
5. TPP Protection from Ice Effects in Northern Regions

#### **Tidal Power Plant Equipment**

151

Igor N. Usachev, *Share -holding Company, Institute Hydroproject, Moscow, Russia*

Lev B. Bernshtein, *Share -holding Company, Institute Hydroproject, Moscow, Russia*

B. Istorik, *Scientific-Research Institute of Energy Structures, Moscow, Russia*

1. History of Turbine Optimization for TPP
2. Straight-Flow Turbine
3. Straight-flow “Straflo” Pilot Unit for the Annapolis TPP
4. Bulb Turbine
5. Rance TPP Bulb Unit
6. Kislaya Guba TPP Bulb Unit with Step-up Gear and Cycle Generator
7. Comparison of the “Straflo” Units and Bulb Units
8. New Orthogonal Turbine for TPP

#### **Environmental Protection and Social Aspects of Tidal Energy**

169

Igor N. Usachev, *Share-holding Company, Institute Hydroproject, Moscow, Russia*

1. Studies of TPP Effect on Environment
2. Assessment of Tidal Barrage Environmental Implications
3. Change of Hydrological Regime at Tidal Barrages
4. Passage of Fish through Tidal Barrages
5. Passage of Plankton through Tidal Barrage
6. Effect of Tidal Power Plants on Bottom Community
7. Studies of Silt in the Basin of Tidal Barrages
8. Change of Water Salinity at Tidal Barrages
9. Influence of Tidal Barrages on Ice Regime
10. Results of 30 Year Ecological Studies at the First Commercial La Rance TPP
11. Ecological Studies for a Large Tidal Barrages in England
12. Main Environmental Advantage
13. Social Significance of Tidal Barrages
14. Global Significance of Environmentally Benign Tidal Barrages

**Economic Aspects of Tidal Energy** **186**

Igor N. Usachev, *Share-holding Company, Institute Hydroproject, Moscow, Russia*

1. Reasons for Rise in the Cost of TPP Construction (Historical Background)
2. Inefficiency of Traditional Technology of TPP Construction behind Cofferdams
3. Possibilities of Significant Reduction of TPP Costs, Using New Equipment
4. Cost-effectiveness of TPP
5. Economic Assessment of TPP Operation Optimized Regime in the Modern Power System
6. Capital and Operating Costs of Modern TPPs

**Future of Tidal Power** **198**

Lev B. Bernshtein, *Stock-holding Company, Institute Hydroproject, Moscow, Russia*

Igor N. Usachev, *Stock-holding Company, Institute Hydroproject, Moscow, Russia*

1. Comparison of Tidal Energy with Other Types of Ocean and River Energy
2. The Role of Tidal Energy in the World Power Engineering
3. Time to Construct TPPs

**Index** **209**

**About EOLSS** **215**