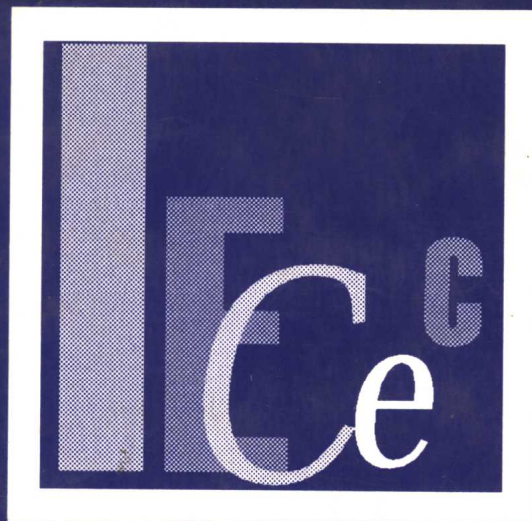




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PROCEEDINGS OF THE  
30TH INTERSOCIETY  
ENERGY CONVERSION  
ENGINEERING CONFERENCE

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VOLUME 3



JULY 30 - AUGUST 4, 1995 • ORLANDO, FLORIDA

72.083  
I-61  
:1995(30(3))



July 30–August 4, 1995  
Orlando, Florida

*"Energy Technologies for a  
Sustainable Future"*

# PROCEEDINGS OF THE 30TH INTERSOCIETY ENERGY CONVERSION ENGINEERING CONFERENCE

**VOLUME 3**

## CONVERSION TECHNOLOGIES

Heat Pumps  
Advanced Cycles  
Thermoelectrics  
Thermionics  
AMTEC

## ELECTROCHEMICAL CONVERSION

Fuel Cells  
Batteries for Terrestrial Applications

## NEW TECHNOLOGIES FOR ENERGY UTILIZATION

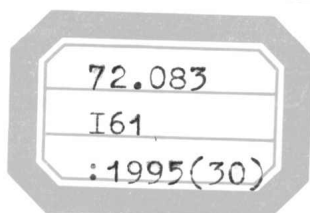
New technologies for energy utilization  
Superconductivity

## STIRLING CYCLES AND MACHINES

Stirling Engine Development  
Stirling Component Analysis/Testing  
Stirling Machine Simulation and Optimization  
Stirling Machine Analysis

edited by

D. Yogi Goswami  
L. D. Kannberg  
T. R. Mancini  
S. Somasundaram



RB248/2

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS  
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ISBN No. 0-7918-1221-9

Library of Congress Catalog Number 67-29948

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# Proceedings of the 30th Intersociety Energy Conversion Engineering Conference

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## **Volume 3**

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## A MESSAGE FROM THE CONFERENCE CHAIRS

On behalf of the American Society of Mechanical Engineers (ASME) and the other sponsoring societies, we invite you to join us at Walt Disney Village in Orlando, Florida, for the 30th Intersociety Energy Conversion Engineering Conference (IECEC). The IECEC Conference has always served as a window into the future of energy technologies. Coincidentally, the discussion about the technologies that will lead us into the next century is being held at a location where the futuristic ideas of Walt Disney provide entertainment as well as educational experiences.

Since the early 1990s, there has been a worldwide discussion on Sustainable Development and at this time the idea has become universally accepted. There is, however, no consensus on what action or set of actions will lead us to a sustainable future. A 1987 report of the World Commission on Environment and Development, "Our Common Future," defined sustainable development as the "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." In practical terms it means providing for food, energy and other necessities in a way that maintains a sustainable level of natural resources and environmental quality. Since energy conversion and utilization have a large impact on natural resources and environmental quality, it is appropriate and timely to discuss the energy technologies that will lead us toward a sustainable future. Hence, the theme for this year's IECEC is *Energy Technologies for a Sustainable Future*.

The IECEC provides a forum to present and discuss the engineering aspects of energy conversion, advanced and unconventional energy systems and devices, energy conversion and utilization, environmental issues and policy implications on research, development, and implementation of technologies. We recognize that no single energy resource or technology will provide for a sustainable future. Instead, the solution will lie in a mix of all of the available energy resources (renewable and non-renewable) and diverse energy conversion technologies that will maintain quality of life in a sustainable manner. IECEC is the only forum that brings experts in all of the energy technologies together for a cross-disciplinary exchange of information. As always, this year's IECEC is expected to bring together participants from academia, government, industry and utilities, and from all continents of the world.

As Orlando is the vacation land of the world, we are arranging social and entertainment activities such as behind-the-scenes Disney tours, reception entertainment, a golf tournament, etc., that will make this conference entertaining, enjoyable, and intellectually stimulating.

Welcome to the 30th IECEC.

D. Yogi Goswami  
Landis Kannberg  
Sriram Somasundaram  
Tom R. Mancini

## ACKNOWLEDGMENTS

The Conference Chairmen gratefully acknowledge the assistance provided by the following staff members of the Battelle Pacific Northwest Laboratory, without whose dedication and generosity of their personal time, the publication of these Proceedings would not have been possible. They send their very best wishes to all attendees and hope that the 1995 IECEC contributes to their future success.

Sue Arey  
Linda Fastabend  
Teresa Fekkether  
Todd Garlick  
Donna Gemeinhart  
Kay Gregory  
Darleen Konzek

# 30th Intersociety Energy Conversion Engineering Conference

Orlando, Florida  
July 31–August 3, 1995

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**Stirling Machine Simulation and Optimization**  
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Canada

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