

Improved, Sustainable and Clean Options for Our Planet

Trevor M. Letcher



FUTURE ENERGY

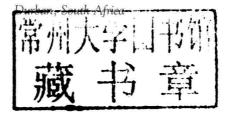
Improved, Sustainable and Clean Options for Our Planet

SECOND EDITION

Edited by

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Elsevier

32 Jamestown Road, London NW1 7BY, UK 225 Wyman Street, Waltham, MA 02451, USA

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British Library Cataloguing-in-Publication Data

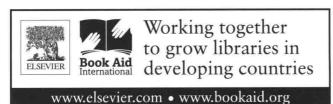
A catalogue record for this book is available from the British Library

Library of Congress Cataloging-in-Publication Data

A catalog record for this book is available from the Library of Congress

ISBN: 978-0-08-099424-6

For information on all Elsevier publications visit our website at store.elsevier.com



FUTURE ENERGY

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Preface

As a result of the interest shown in the first edition of Future Energy, and because the subject has expanded enormously with new developments in traditional fields and new approaches in emerging technologies, a new edition of the book has been produced with 31 chapters as opposed to the 20 chapters in the first edition. The new edition has additional chapters devoted to hydraulic fracturing, coal-bed methane, LNG as a transport fuel, lithium ion batteries, hydrogen as an energy carrier, carbon dioxide capture and sequestration, energy storage systems, environmental impacts of energy production, distribution and transport, smart grids, energy resources in developing countries, transition to future energy, and energy options and predictions in China. China has been singled out as it is the most rapidly developing superpower, and if its development continues at its present rate, it will soon produce more energy than any other country on Earth. It is already producing more carbon dioxide by utilisation of fossil fuels than any other country.

The book looks at all types of energy that may be used in the future including the sustainable types such as solar, wind, tidal and wave energy. Fossil fuel in all its forms, from coal, oil, methane gas and methane hydrates, occupies a prominent place in this book as these energy sources will be with us for many decades before we have expanded and developed renewable energy forms, built new nuclear fission plants or possibly even developed new types of energy such as nuclear fusion (Chapter 10) and space solar power (not included in this book) in which orbiting solar panels collect energy from the sun and beam it back down to Earth using lasers or microwaves.

This book, like the first edition, has been produced in order to allow the reader to have a reasonable, logical and correct understanding and insight into our future use of energy. The final decision as to which energy options should be developed in a country or region must take into account many factors including sustainability, the general safety and health of the general public, the overall energy requirements of society, the geographical position of each region, and above all, the alarming rise in atmospheric carbon dioxide over the past 50 years, which threatens to change the world's future climate through global warming.

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The first edition of this book had its origins in the committee meetings of the International Association of Chemical Thermodynamics (IACT), an organisation affiliated to the International Union of Pure and Applied Chemistry (IUPAC).² The logo of the IACT is on the front cover of this book. The book is supported by IUPAC through its Physical Chemistry Division and the IUPAC's logo also appears on the front cover.³ The IUPAC's adherence to the International System of Quantities, via editing by its Interdivisional Committee for Terminology, Nomeclature and Symbols (ICTNS), is reflected in the book with the use of SI units throughout. Flexibility and accommodation are ensured for various constituencies by including alternate non-SI units that may be more familiar to specific areas. The ICTNS4 and the Commission on Physiochemical Symbols, Terminology and Units⁵ provide the so-called Green Book⁶ that is available online. The index notation is used to remove any ambiguities; for example, billion and trillion are written as 10^9 and 10^{12} , respectively. To further remove any ambiguities the concept of the quantity calculus is used. It is based on the equation: physical quantity = number \times unit. To give an example: power = 200 W and hence: 200 = power/W. This is of particular importance in the headings of tables and the axis labels of graphs. One can only plot a number on a graph and the axis label reflects this reality.

This volume is unique in the genre of books of similar or related titles currently on sale in that each chapter of *Future Energy* has been written by an expert scientist or engineer, working in the field. Authors have been chosen for their expertise in their respective fields and come

¹www.iactweb.org

²www.iupac.org

³http://www.iupac.org/nc/home/projects/project-db/project-details.html? tx_wfqbe_pi1%5Bproject_nr%5D = 2012-041-1-100

 $^{^4}$ http://www.iupac.org/nc/home/about/members-and-committees/db/division-committee.html?tx_wfqbe_pi1%5Btitle%5D = Interdivisional%20Committee%20on%20Terminology%2C%20Nomenclature%20and%20Symbols&tx_wfqbe_pi1%5Bpublicid%5D = 027

⁶R.E. Cohen, T. Cvitaš, J.G. Frey, B. Holmstróm, K. Kuchitsu, R. Marquardt, et al., Quantities, Units and Symbols in Physical Chemistry, For IUPAC, RSC Publishing, Colchester, UK, 2007.

⁷http://www.iupac.org/nc/home/publications/e-resources/nomenclature-and-terminology/quantities-units-and-symbols-in-physical-chemistry-green-book.html? sword_list%5B%5D = book

PREFACE **xvii**

from 21 countries: Australia, Belgium, Brazil, Canada, China, England, Finland, France, Germany, India, Indonesia, Ireland, Italy, Japan, Luxembourg, Korea, The Netherlands, Norway, Scotland, South Africa and the United States of America.

This book is divided into eight sections:

- Introduction
- Fossil fuels (energy sources)
- Nuclear power (energy sources)
- Transport energy (energy sources)
- Transport energy (energy storage)
- Renewable energy (energy sources)
- · New possible energy options
- Environmental and related issues.

A vital concern of future energy options is: what is to be done when it appears that politicians misunderstand or ignore and corporations overlook the realities of finite fuel sources and our changing climate? The solution lies in sound scientific data and education. As educators we believe that only a sustained grassroots movement, to educate citizens, politicians and corporate leaders of the world, has any hope of success. This book is part of that education process. It presents a non-political and unemotional set of energy options for readers to consider and arrive at sensible solutions to the problems facing the world today. We hope that not only students, teachers, professors and researchers of new energy, but politicians, government decision makers, captains of industry, corporate leaders, journalists, editors and all interested people will read the book, take heed of its contents and absorb its underlying message.

I wish to thank all the authors for their co-operation, help and especially for writing their chapters. It has been a pleasure working with each and every one of our authors. I thank my wife, Valerie, for all the help she has given me over these long months of putting the book together. I also thank Sean Coombs and Jill Cetel of Elsevier for their help in getting this volume together. Finally I wish to thank Professor Ron Weir of IUPACs ICTNS for his help with the editing.

Trevor M. Letcher Stratton-on-the-Fosse Somerset 5 August 2013

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