

# Energy Economics

Subhes C. Bhattacharyya

# Energy Economics

Concepts, Issues, Markets and Governance

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Dr. Subhes C. Bhattacharyya  
Centre for Energy, Petroleum and Mineral  
Law and Policy  
University of Dundee, UK  
e-mail: S.C.Bhattacharyya@dundee.ac.uk;  
subhes\_bhattacharyya@yahoo.com

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# Preface

The idea for this book came about 4 years ago when I attended a workshop in Oxford on energy economics teaching in the U.K. organised under the auspices of the UK Energy Research Centre (UKERC). That was a time when oil prices started its upward journey and concerns about the security of energy supply were becoming a common man issue. It occurred to me that despite this great interest in understanding the common energy problems around us, there is a lack of critical appreciation of the problem and its inter-linkages with other issues. While the interest in the field of energy studies has seen a tremendous growth over the past decade, there is a serious gap in terms of a holistic understanding of the energy problems around us. That workshop clearly demonstrated that the economic concepts that are relevant to the energy industry are poorly understood by researchers of inter-disciplinary background. The main reason behind this state of affairs is the lack of a good, accessible reference book in energy economics that anyone interested in the subject can hold onto.

Luckily for me, this revelation came as a good opportunity to deliver such a book. Last year, 2010, marked the completion of 25 years of my continuous involvement with the energy field of study. I have been teaching the subject to students of inter-disciplinary backgrounds for quite sometime now. I have taught various aspects of energy economics and policies, and have provided training to senior staff. Moreover, having worked in the industry and in high level professional consulting, I understand the need for a balanced approach for such a book. In addition, my current research focuses on practical, applied problems where technology, engineering, economics, finance, regulation and the environment all feature in different proportions. This came handy while preparing for this book.

My desire to put a holistic picture by including various dimensions of the problem in the book has meant that the size has gone up. The feedback from my students has influenced the outline and the content of the book. While all of them want to gain some analytical skills and concepts so that they can analyse any given problem using simple economic logic, they have also shown great interests in understanding the environmental aspects related to energy use and the regulation and governance of the industry. I have complied with their desires and hope that

this volume helps any reader to gain a wider and balanced understanding of the energy issues.

Most of the content of the book is accessible to persons of non-mathematical background. The economic concepts have also been explained in simple terms, often using graphical presentations. However, for those who cannot imagine an energy economics book without mathematics, I have added some materials and have provided references for further reading. Essentially, mathematics has been used as an aid and not for the sake of it.

I am grateful to my students who provided valuable feedback and encouraging comments on most of the materials of this book that have been tested in various classes. Their questions and reflections/ criticisms have always helped me in improving my work. Although I have included additional materials based on my personal research activities or to reflect the changes taking place in the energy sector, I am very confident that other readers would find the content useful to them. I am also thankful to my colleagues with whom I have co-authored some of my academic publications that are included in this book under various chapters. However, I am only responsible for any errors and omissions that may still remain.

A book of this size always takes special personal efforts. Although I thought I would be able to complete the work in a short period of time given the state of preparedness of the initial manuscripts, it proved too optimistic in the end. I am thankful to Ms Claire Protherough and Mr Anthony Doyle for their understanding and flexibility. Above all, I could not have realised this work without the support and sacrifice of my family members—my spouse Debjani and my daughter Saloni. The order in which your names appear in the print does not matter—you are always special and priceless to me.

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# Abbreviations

## A

AAU	Assigned Allocation Units
AC	Average cost
ADB	Asian Development Bank
ANN	Artificial neural network
APERC	Asia Pacific Energy Research Centre
ARIMA	Integrated Auto regressive moving average
ARMA	Auto regressive moving average

## B

BCM	Billion cubic metres
BF	Blast furnace
BP	British Petroleum

## C

CAIR	Clean Air Interstate Rule
cal	Calories
CAPM	Capital asset pricing model
CBO	Congressional Budget Office (US)
CC	Combined cycle
CDD	Cooling degree days
CDM	Clean Development Mechanism
CEGB	Central Electricity Generation Board
CER	Certified emissions reductions
CERI	Canadian Energy Research Institute
CES	Constant elasticity of substitution
CF	Capacity factor
CFC	Chlorofluorocarbon

CFL	Compact fluorescent lamp
CGE	Computable General Equilibrium model
CHP	Combined heat and power
CIF	Cost insurance freight
CNG	Compressed natural gas
CO <sub>2</sub>	Carbon-di-oxide
COP	Conference of Parties
COPD	Chronic pulmonary obstructive disease
CPI	Consumer price index
CRA	Charles River Associates
CRF	Capital recovery factor

## D

DCF	Discounted cash flow
DECC	Department of Energy and Climate Change (UK)
DfID	Department for International Development
DNA	Designated National Authority
DOE	Designated Operational Entities (CDM) Department of Energy (US)
DR(I)	Direct reduction (of Iron in steel making)
DSM	Demand-side management
DTI	Department of Trade and Industry (UK)
DWL	Deadweight loss

## E

EB	Executive Board (CDM)
EC	European Commission
ECA	Energy Commodity Account
ECM	Error correction model
EDI	Energy Development Index
EEA	European Environment Agency
EGEAS	Electric Generation Expansion Analysis System
EIA	Energy Information Administration (of the Department of Energy, USA)
EMV	Expected monetary value
EPA	Environment Protection Agency (US)
EPRI	Electric Power Research Institute
ESI	Electricity supply industry
ESP	Electrostatic precipitator
ETS	Emissions trading system
EU	European Union

**F**

FAO	Food and Agricultural Organisation
FGD	Flue gas desulphurisation
FOB	Free on board
FSU	Former Soviet Union (countries)

**G**

GCC	Gulf Co-operation Council
GDP	Gross domestic product
GGFR	Global gas flaring reduction
GHG	Greenhouse gas
GWh	Giga watt hour
GWP	Global Warming potential

**H**

HDD	Heating degree days
HH	Henry Hub (US)
HHI	Herfindahl Hirschman Index

**I**

IAEA	International Atomic Energy Agency
IEA	International Energy Agency
IGCC	Integrated Gasified combined cycle
IIASA	International Institute for Applied Systems Analysis
IMF	International Monetary Fund
IOC	International Oil companies
IPCC	Inter-Governmental Panel on Climate Change
IPP	Independent Power producers
IRR	Internal rate of return

**J**

JI	Joint Implementation (projects)
JODI	Joint Oil Data Initiative

**K**

kcal	Kilo calories
KP	Kyoto Protocol
kW	Kilo watt

**L**

LEAP	Long-range Energy Alternatives Planning
LF	Load factor
LNG	Liquefied Natural Gas
LPG	Liquid petroleum gas
LULUCF	Land use, land use change and forestry

**M**

MAED	Model for analysis of energy demand
MARKAL	Market Allocation model
MBMS	Multi-buyer multi-seller
MC	Marginal cost
MENA	Middle East and North African countries
Mt	Million tons (metric)

**N**

NBP	National Balancing Point (UK)
NEMS	National Energy Modelling system
NGL	Natural Gas Liquids
NOC	National oil companies
NO <sub>x</sub>	Nitrous oxides
NPV	Net present value

**O**

OEB	Overall Energy Balance
OECD	Organisation for Economic Co-operation and Development
OPEC	Organisation of the Petroleum Exporting Countries
OTC	Ozone Transport Commission

**P**

PBR	Performance-based regulation
PDD	Project design document
PES (PEC)	Primary energy supply (Primary energy consumption)
PM	Particulate matters
PPP	Purchasing power parity

**R**

R&D	Research and development
RCEP	Royal Commission on Environmental Protection (UK)
RE	Renewable energies (if not otherwise indicated)
RES	Reference Energy System
RIM	Ratepayer impact test
RO	Renewable obligation
ROC	Renewables Obligation certificate
RPI	Retail price index

**S**

SAM	Social Accounting Matrix
SD	Sustainable development
SHS	Solar Home systems
SIP call	State Implementation Plan call
SOE	State owned enterprise
SO <sub>x</sub>	Sulphur Oxides
SWI	Shannon Wiener Index
SWNI	Shannon Wiener Neumann Index

**T**

T&D	Transmission and distribution
TCF	Trillion cubic feet
TE	Traditional energies
TFC	Total final consumption
TFP	Total factor productivity
TFS	Total final supply
TPA	Third party access

**U**

UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollar

**V**

VIM	Vertically integrated model
VOC	Volatile organic compounds

**W**

WACC	Weighted average cost of capital
WASP IV	Wien Automatic System Planning Package IV
WB	World Bank
WEC	World Energy Council
WEM	World Energy Model
WEO	World Energy Outlook
WHO	World Health Organisation