

ENCYCLOPEDIA OF
**ENERGY, NATURAL
RESOURCE, AND
ENVIRONMENTAL ECONOMICS**

ENCYCLOPEDIA OF **ENERGY, NATURAL RESOURCE, AND ENVIRONMENTAL ECONOMICS**

EDITOR-IN-CHIEF
JASON F SHOGREN

*University of Wyoming,
Laramie, WY, USA*

VOLUME 1
ENERGY



AMSTERDAM BOSTON HEIDELBERG LONDON NEW YORK OXFORD
PARIS SAN DIEGO SAN FRANCISCO SINGAPORE SYDNEY TOKYO

Elsevier
32 Jamestown Road, London NW1 7BY, UK
225 Wyman Street, Waltham, MA 02451, USA
525 B Street, Suite 1900, San Diego, CA 92101-4495, USA

Copyright © 2013 Elsevier Inc. All rights reserved.

The following articles are US government works in the public domain and are not subject to copyright:

Markets/Technology Innovation/Adoption/Diffusion: Energy-Efficiency Gap
Non-Renewable Fossil/Nuclear/Electricity Markets: Modeling Reserve Growth in Natural Gas Fields
Policies/Incentives: Standards

No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means electronic, mechanical, photocopying, recording or otherwise without the prior written permission of the publisher.

Permissions may be sought directly from Elsevier's Science & Technology Rights Department in Oxford, UK: phone (+44) (0) 1865 843830; fax (+44) (0) 1865 853333; email: permissions@elsevier.com.

Alternatively you can submit your request online by visiting the Elsevier web site at (<http://elsevier.com/locate/permissions>), and selecting *Obtaining permission to use Elsevier material*.

Notice

No responsibility is assumed by the publisher for any injury and/or damage to persons or property as a matter of products liability, negligence or otherwise, or from any use or operation of any methods, products, instructions or ideas contained in the material herein. Because of rapid advances in the medical sciences, in particular, independent verification of diagnoses and drug dosages should be made.

British Library Cataloguing in Publication Data

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

Library of Congress Catalog Number

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

ISBN: 978-0-12-375067-9

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

Typeset by Spi Global www.spi-global.com

Printed and bound in the United States of America

13 14 15 16 17 10 9 8 7 6 5 4 3 2 1

		Working together to grow libraries in developing countries
www.elsevier.com • www.bookaid.org		

Editorial: Esmond Collins, Richard Berryman and Marise Willis
Production: Nicky Carter

EDITORIAL BOARD

Editor in Chief

Professor Jason F Shogren

Department of Economics and Finance, University of Wyoming, Laramie, WY, USA

Associate Editors

Professor Runar Brännlund

Centre for Environmental and Resource Economics, Department of Economics, Umeå University, Umeå, Sweden

Professor Erwin Bulte

Development Economics Group, Wageningen University, Wageningen, and Department of Economics, Tilburg University, Tilburg, The Netherlands

Professor Richard Horan

Department of Agricultural, Food and Resource Economics, Michigan State University, East Lansing, MI, USA

Professor Catherine Kling

Department of Economics and Center for Agricultural and Rural Development, Iowa State University, Ames, IA, USA

Professor Stephan Kroll

Department of Agricultural and Resource Economics, Colorado State University, Fort Collins, CO, USA

Professor Brent Sohngen

Department of Agriculture, Environmental and Development Economics, The Ohio State University, Columbus, OH, USA

Volume 1 Energy

Maximilian Auffhammer

Department of Agricultural and Resource Economics, University of California at Berkeley, Berkeley, CA, USA

Timothy J Considine

Department of Economics and Finance, University of Wyoming, Laramie, WY, USA

Bengt J Kriström

Department of Forest Economics, Swedish University of Agricultural Sciences (SLU), Center for Environmental and Resource Economics, Umeå University, Umeå, Sweden

Klaas T van 't Veld

Department of Economics & Finance, University of Wyoming, Laramie, WY, USA

Volume 2 Resources

Peter Berck

Department of Agricultural and Resource Economics & Policy, University of California, Berkeley, Berkeley, CA, USA

Robert T Deacon

Department of Economics, University of California, Santa Barbara, CA, USA

Aart DeZeeuw

Tilburg School of Economics and Management, Tilburg University, Tilburg, The Netherlands

Charles F Mason

Department of Economics & Finance, University of Wyoming, Laramie, WY, USA

Rick van der Ploeg

Oxford Centre for the Analysis of Resource Rich Economics, New College, University of Oxford, Oxford, UK

Junjie Wu

Department of Agricultural and Resource Economics, Oregon State University, Corvallis, OR, USA

Volume 3 Environment

Per G Fredriksson

Department of Economics, College of Business, University of Louisville, Louisville, KY, USA

Joseph A Herriges

Department of Economics, Iowa State University, Ames, IA, USA

John B Loomis

Department of Agricultural and Resource Economics, Colorado State University, Fort Collins, CO, USA

Kathleen Segerson

Department of Economics, University of Connecticut, Storrs, CT, USA

James S Shortle

Department of Agricultural Economics & Rural Sociology, The Pennsylvania State University, University Park, PA, USA

EDITOR BIOGRAPHIES



Jason F. Shogren is the Stroock Professor of Natural Resource Conservation and Management and Chair of the Department of Economics and Finance at the University of Wyoming, his alma mater. He works on the economics of environmental and natural resource policy. Jason is a foreign member of the Royal Swedish Academy of Sciences, and has served as professor to the King of Sweden, a lead author for the Intergovernmental Panel on Climate Change, and as a senior economist on the Council of Economic Advisers in the White House. He likes music and fishing.



Runar Brännlund is currently a professor in the Department of Economics, Umeå School of Business and Economics, Umeå University, Sweden. He also acts as deputy research director at the Centre for Environmental and Resource Economics, Umeå, Sweden. His research interests cover several areas within the field of environmental, resource, and energy economics, as well as public economics. He has been acting as expert and secretary to a number of Swedish governmental commissions, such as the Green Tax Commission and the governmental scientific council for climate change. He is also an elected member of the Royal Swedish Academy of Engineering Sciences, and the editor-in-chief for the *Journal of Forest Economics* (Elsevier).



Erwin Bulte is a professor of development economics at Wageningen University, and professor of environmental and resource economics at Tilburg University (both in the Netherlands). His research interests include experimental economics and institutional economics, and the process of post-conflict recovery. Erwin has published more than 100 papers in internationally refereed journals.



Richard Horan is a professor of environmental and natural resource economics in the Department of Agricultural, Food, and Resource Economics at Michigan State University. His research interests lie mainly in the design of economic policies for managing coupled economic and ecological systems, with emphases on invasive species and pathogens, species conservation, and water quality. He has served as an associate editor or on the editorial boards of the *American Journal of Agricultural Economics*, *Natural Resource Modeling*, *International Review of Environmental and Resource Economics*, and *Resource and Energy Economics*, and he is currently a coeditor of *Resource and Energy Economics*.



Catherine Kling is a professor of economics, Fellow of the Agricultural and Applied Economics Association, and current president of the Association of Environmental and Resource Economists. She is currently interim director of CARD, where she leads the Resource and Environmental Policy Division, an interdisciplinary research group focusing on water quality and agricultural practices. Catherine has published over 60 journal articles and refereed book chapters, has received seven awards from professional associations for her research, has been PI (or co-PI) on over \$7 million of grants (including NSF, EPA, USDA, and state agencies) and holds (or has held) editorial positions at seven economics journals. Catherine's engagement in the policy process includes over 10 years of service as a member of EPA's Science Advisory Board and member of five National Academy of Science panels. Fifteen of her former PhD and post-doctoral students now hold academic positions.



Stephan Kroll (PhD 1999, University of Wyoming) has been an associate professor in the Department of Agricultural and Resource Economics at Colorado State University since 2008. His previous experience includes positions at St. Lawrence University and California State University, Sacramento, as well as teaching and research stints in Norway, Germany, Austria, and Vietnam.

Stephan is an environmental and experimental economist with research interests in the design of market institutions and policy tools, and the study of public goods. He has published his research in journals such as the *Journal of Environmental Economics and Management*, *Economic Inquiry*, *Public Choice*, *Journal of Conflict Resolution*, and *Environmental Science and Policy*, and he is a coeditor of a book on experimental methods in environmental economics.



Brent L. Sohngen is a professor of environmental and natural resource economics in the Department of Agricultural, Environmental, and Development Economics at the Ohio State University. He conducts research on the sustainability of land and natural resources, and economic policies for controlling pollution and modeling the impacts of climate change. Brent teaches courses entitled 'World Population, Food and Environment' and 'Energy, the Environment and the Economy.'

CONTRIBUTORS

J K Abbott
Arizona State University, Tempe, AZ, USA

D M Adams
Oregon State University, Corvallis, OR, USA

T S Aidt
University of Cambridge, Cambridge, UK

H J Albers
Oregon State University, Corvallis, OR, USA

R J Alig
Retired, USDA Forest Service, Pacific Northwest Research Station, Corvallis, OR, USA

J-C Altamirano-Cabrera
Universidad Autónoma Metropolitana-Azcapotzalco, Mexico City, Mexico

G S Amacher
Virginia Polytechnic Institute and State University, Blacksburg, VA, USA

T L Anderson
Property and Environment Research Center (PERC), Bozeman, MT, USA; Hoover Institution, Stanford, CA, USA

A W Ando
University of Illinois at Urbana-Champaign, Urbana, IL, USA

R Arnason
University of Iceland, Reykjavik, Iceland

G B Asheim
University of Oslo, Oslo, Norway

E D Attanasi
US Geological Survey, Reston, VA, USA

E Baker
University of Massachusetts, Amherst, MA, USA

H S Banzhaf
Georgia State University, Atlanta, GA, USA

E B Barbier
University of Wyoming, Laramie, WY, USA

R Barron
University of Massachusetts, Amherst, MA, USA

A M Bento
Cornell University, Ithaca, NY, USA

A Bergmann
University of Dundee, Dundee, Scotland, UK

E Blanc
Massachusetts Institute of Technology, Cambridge, MA, USA

N Boccard
Universitat de Girona, Girona, Spain

C Böhringer
University of Oldenburg, Oldenburg, Germany

J R Boyce
University of Calgary, Calgary, AB, Canada

J B Braden
University of Illinois, Urbana, IL, USA

K Brouhle
Grinnell College, Grinnell, IA, USA

S Bucaram
University of California, Davis, CA, USA

D Burtraw
Resources for the Future, Washington, DC, USA

R D Cairns
McGill University, Montreal, QC, Canada

M R Caputo
University of Central Florida, Orlando, FL, USA

S Cardenas
University of California, Davis, CA, USA

C Carraro
University Ca' Foscari of Venice, Venezia, Italy

U Chakravorty
Tufts University, Medford, MA, USA

T L Cherry
Appalachian State University, Boone, NC, USA; CICERO
Center for International Climate and Environmental
Research, Oslo, Norway

M A Cohen
Vanderbilt University and Resources for the Future,
Nashville, TN, USA

M J Coren
Climate Focus, Washington, DC, USA

S Cotten
University of Houston – Clear Lake, Houston, TX, USA

A-S Crépin
The Beijer Institute of Ecological Economics, Stockholm,
Sweden

F P de Vries
University of Stirling, Stirling, UK

A de Zeeuw
Tilburg University, Tilburg, The Netherlands

R T Deacon
University of California, Santa Barbara, CA, USA

G M Dempster
Hampden-Sydney College, Hampden Sydney, VA, USA

C Di Maria
University of Birmingham, Birmingham, UK

M Dickie
University of Central Florida, Orlando, FL, USA

A Doerr
University of California, Davis, CA, USA

J M Duke
University of Delaware, Newark, DE, USA

D Eamhart
University of Kansas, Lawrence, KS, USA

O Edenhofer
Potsdam Institute for Climate Impact Research (PIK),
Potsdam, Germany; IPCC Working Group III; Mercator
Research Institute on Global Commons and Climate
Change (MCC), Berlin, Germany

K Ek
Luleå University of Technology, Luleå, Sweden

D E Ervin
Portland State University, Portland, OR, USA

R Färe
Oregon State University, Corvallis, OR, USA

C Fischer
Resources for the Future, Washington, DC, USA

T Fleiter
Fraunhofer Institute for Systems and Innovation Research,
Karlsruhe, Germany

F R Førsund
University of Oslo, Oslo, Norway

T J Foxon
University of Leeds, Leeds, UK

P G Fredriksson
University of Louisville, Louisville, KY, USA

K Fuller
University of California, Davis, CA, USA

R Gerlagh
Tilburg University, Tilburg, The Netherlands

C Gollier
Toulouse School of Economics (LERNA and IDEI),
Toulouse, France

P Gong
Swedish University of Agricultural Sciences, Umeå,
Sweden

R L Gordon
The Pennsylvania State University, Pennsylvania, PA,
USA

M Goulder
Hamilton College, Clinton, NY, USA

R Q Grafton
The Australian National University, Canberra, ACT,
Australia

M Greaker
Statistics Norway, Oslo, Norway; Gothenburg University,
Göteborg, Sweden

S Grosskopf
Oregon State University, Corvallis, OR, USA

S Gulati
University of British Columbia, Vancouver, BC, Canada

T C Haab
The Ohio State University, Columbus, OH, USA

N Hanley
University of Stirling, Stirling, Scotland

R Hannesson
Norwegian School of Economics, Bergen, Norway

B Harstad
University of Oslo, Oslo, Norway

- I Haščić
OECD Environment Directorate, Paris, France
- G Heal
Columbia Business School, New York, NY, USA
- G E Helfand
U.S. Environmental Protection Agency, Ann Arbor, MI, USA
- A Heyes
University of Ottawa, Ottawa, ON, Canada
- R L Hicks
The College of William and Mary, Williamsburg, VA, USA
- D S Holland
Northwest Fisheries Science Center, NOAA/NMFS, Seattle, WA, USA
- S P Holland
University of North Carolina, Greensboro, NC, USA
- L Hotte
University of Ottawa, Ottawa, ON, Canada
- G Howard
Ohio State University, Columbus, OH, USA
- R B Howarth
Dartmouth College, Hanover, NH, USA
- R Innes
University of California, Merced, CA, USA
- J P Isaacs
Hampden-Sydney College, Hampden Sydney, VA, USA
- W K Jaeger
Oregon State University, Corvallis, OR, USA
- M A Janssen
Arizona State University, Tempe, AZ, USA
- S Jardine
University of California, Davis, CA, USA
- R J Johnston
Clark University, Worcester, MA, USA
- N Johnstone
OECD Environment Directorate, Paris, France
- S Kallbekken
Center for International Climate and Environmental Research – Oslo (CICERO), Norway
- L Karp
University of California, Berkeley, CA, USA
- D Kellenberg
University of Montana, Missoula, MT, USA
- K Keller
Pennsylvania State University, University Park, PA, USA
- R Kemp
Maastricht University, Maastricht, The Netherlands
- M Khanna
University of Illinois at Urbana-Champaign, Urbana, IL, USA
- K A Kiel
College of the Holy Cross, Worcester, MA, USA
- T C Kinnaman
Bucknell University, Lewisburg, PA, USA
- H Klemick
National Center for Environmental Economics, U.S. Environmental Protection Agency, Washington, DC, USA
- D Kling
University of California, Davis, CA, USA
- T J Kniesner
Syracuse University, Syracuse, NY, USA; IZA, Bonn, Germany
- B Kriström
CERE, SLU, Umeå, Sweden
- K Kroetz
University of California, Davis, CA, USA
- S Kroll
Colorado State University, Fort Collins, CO, USA
- H Kunreuther
University of Pennsylvania, Philadelphia, PA, USA
- J Ladenburg
KORA, Danish Institute for Local and Regional Government Research, Copenhagen, Denmark
- Y-B Lai
National Chengchi University, Taipei City, Taiwan, Republic of China
- A Lange
University of Hamburg, Hamburg, Germany
- E Lanzi
OECD, Paris, France
- K Lawlor
University of North Carolina, Chapel Hill, NC, USA
- J D Leeth
Bentley University, Waltham, MA, USA
- E Lichtenberg
University of Maryland, College Park, MD, USA
- M Liski
Aalto University, Helsinki, Finland

C Liston-Heyes
University of Ottawa, Ottawa, ON, Canada

M J Livingston
US Department of Agriculture, Washington, DC, USA

K-G Löfgren
Umeå University, Umeå, Sweden

A Löschel
Centre for European Economic Research (ZEW), Mannheim, Germany; University of Heidelberg, Heidelberg, Germany

D Lund
University of Oslo, Blindern, Oslo, Norway

T Lundgren
SLU/Umeå University, Umeå, Sweden

P-O Marklund
SLU/Umeå University, Umeå, Sweden

E Massetti
Yale University, New Haven, CT, USA

G E Metcalf
Tufts University, Medford, MA, USA; NBER, Cambridge, MA, USA

T O Michielsen
Tilburg University, Tilburg, The Netherlands

K T Midthun
SINTEF Technology and Society, Trondheim, Norway

D L Millimet
Southern Methodist University, Dallas, TX, USA; IZA, Bonn, Germany

K Millock
Paris School of Economics, CNRS, Paris, France

C A Montgomery
Oregon State University, Corvallis, OR, USA

B C Murray
Duke University, Durham, NC, USA

G F Nemet
University of Wisconsin-Madison, Madison, WI, USA

V S Nørstebo
SINTEF Technology and Society, Trondheim, Norway

R Oonsie Biggs
Stockholm Resilience Centre, Stockholm, Sweden

D A Ovando
University of California, Santa Barbara, CA, USA

D P Parker
The University of Wisconsin, Madison WI, USA

G M Parkhurst
Weber State University, Ogden, UT, USA

I Parry
International Monetary Fund, Washington, DC, USA

G R Parsons
University of Delaware, Newark, DE, USA

C Pasurka
US Environmental Protection Agency, Washington, DC, USA

A Pfaff
Duke University, Durham, NC, USA

P Plötz
Fraunhofer Institute for Systems and Innovation Research, Karlsruhe, Germany

S Polasky
University of Minnesota, St. Paul, MN, USA

S Pontoglio
European Research Council, Brussels

A Randall
University of Sydney, Sydney, NSW, Australia

J M Reilly
Massachusetts Institute of Technology, Cambridge, MA, USA

M N Reimer
University of California, Davis, CA, USA

T Requate
Kiel University, Kiel, Germany

A Riddle
Resources for the Future, Washington, DC, USA

E J Z Robinson
University of Gothenburg, Gothenburg, Sweden

R S Rosenberger
Oregon State University, Corvallis, OR, USA

N Ross
University of California, Davis, CA, USA

J A Roumasset
University of Hawai'i, Honolulu, HI, USA

J Rubin
University of Maine, Orono, ME, USA

J N Sanchirico
University of California, Davis, CA, USA; Resources for the Future, Washington, DC, USA

B Scarborough
Property and Environment Research Center (PERC), Bozeman, MT, USA

M Schymura
Centre for European Economic Research (ZEW),
Mannheim, Germany

R A Sedjo
Resources for the Future, Washington, DC, USA

K Segerson
University of Connecticut, Storrs, CT, USA

K Seyboth
Potsdam Institute for Climate Impact Research (PIK),
Potsdam, Germany; IPCC Working Group III

W D Shaw
Texas A&M University, College Station, TX, USA

J P Shimshack
Tulane University, New Orleans, LA, USA

J F Shogren
University of Wyoming, Laramie, WY, USA

J S Shortle
Pennsylvania State University, University Park, PA, USA

E O Sills
North Carolina State University, Raleigh, NC, USA

S Siriwardena
University of Maine, Orono, ME, USA

A Skonhoft
Norwegian University of Science and Technology
(NTNU), Trondheim, Norway

E C Smith
The Nature Conservancy, Cold Springs Harbor, NY, USA

P Söderholm
Luleå University of Technology, Luleå, Sweden

D Squires
National Marine Fisheries Service, La Jolla, CA, USA;
University of California, San Diego, CA, USA

S L Stafford
College of William and Mary, Williamsburg, VA, USA

J K Stranlund
University of Massachusetts, Amherst, MA, USA

C Streck
Climate Focus, Washington, DC, USA

S K Swallow
University of Connecticut, Storrs, CT, USA

J Swierzbinski
University of Aberdeen, Aberdeen, UK

L O Taylor
North Carolina State University, Raleigh, NC, USA

W N Thurman
North Carolina State University, Raleigh, NC, USA

A Tomasgard
Norwegian University of Science and Technology,
Trondheim, Norway

C Traeger
University of California, Berkeley, CA, USA

N Treich
Toulouse School of Economics (LERNA and IDEI),
Toulouse, France

M Troell
The Beijer Institute of Ecological Economics, Stockholm,
Sweden

E van der Werf
Wageningen University, Wageningen, The Netherlands

G C van Kooten
University of Victoria, Victoria, BC, Canada

N Van Long
McGill University, Montreal, QC, Canada

D van Soest
VU University Amsterdam, Amsterdam, The Netherlands;
Tilburg University, Amsterdam, The Netherlands

C A Wada
University of Hawai'i, Honolulu, HI, USA

F Wagener
Universiteit van Amsterdam, Amsterdam, The
Netherlands

G Wagner
Environmental Defense Fund, New York, NY, USA;
Columbia University's School of International and Public
Affairs, New York, NY, USA

M Walls
Resources for the Future, Washington, DC, USA

L Wangler
Institut für Innovation und Technik (iit), Berlin,
Germany

L R Watson
Property and Environment Research Center (PERC),
Bozeman, MT, USA

H-P Weikard
Wageningen University, Wageningen, The Netherlands

D Weisbach
University of Chicago Law School, Chicago, IL, USA

A S Werner
SINTEF Technology and Society, Trondheim, Norway

J C Whitehead

Appalachian State University, Boone, NC, USA

J E Wilen

University of California, Davis, CA, USA

C Withagen

VU University Amsterdam, Amsterdam, The Netherlands

J R Wollscheid

*University of Arkansas-Fort Smith, Fort Smith,
AR, USA*

A Wolverton

*National Center for Environmental Economics, U.S.
Environmental Protection Agency, Washington,
DC, USA*

N D Woods

University of South Carolina, Columbia, SC, USA

A Xepapadeas

*Athens University of Economics and Business, Athens,
Greece*

H Yoon

University of California, Davis, CA, USA

CONTENTS

<i>Editorial Board</i>	<i>v</i>
<i>Editor Biographies</i>	<i>vii</i>
<i>Contributors</i>	<i>ix</i>
<i>Preface</i>	<i>xxiii</i>
<i>How to use the Encyclopedia</i>	<i>xxiv</i>

VOLUME 1

ENERGY

Climate Change and Policy	1
Carbon Cap and Trade	1
<i>G Wagner</i>	
Carbon Offsets	6
<i>G C van Kooten and F P de Vries</i>	
Carbon Taxes	9
<i>G E Metcalf and D Weisbach</i>	
Clean Development Mechanism	15
<i>K Millock</i>	
Climate Change and Food Situation	22
<i>E Blanc and J M Reilly</i>	
Dealing with the Uncertainty About Climate Change	30
<i>G Howard</i>	
Double Dividend	37
<i>W K Jaeger</i>	
Economics of Forest Carbon Sequestration as a Climate Change Mitigation Strategy	41
<i>B C Murray</i>	
Intergovernmental Panel on Climate Change (IPCC)	48
<i>O Edenhofer and K Seyboth</i>	
International Climate Treaties and Coalition Building	57
<i>C Carraro and E Massetti</i>	
Markets/Technology Innovation/Adoption/Diffusion	63
Diffusion of Energy-Efficient Technologies	63
<i>T Fleiter and P Plötz</i>	
Energy-Efficiency Gap	74
<i>H Klemick and A Wolverton</i>	

Impacts of Innovation: Lessons from the Empirical Evidence <i>E Lanzi</i>	82
Modeling Technological Change in Economic Models of Climate Change <i>A Löschel and M Schymura</i>	89
Policy Incentives for Energy and Environmental Technological Innovation: Lessons from the Empirical Evidence <i>N Johnstone and I Haščić</i>	98
Technological Change and Climate Change Policy <i>G F Nemet</i>	107
Technological Change and the Marginal Cost of Abatement <i>E Baker and R Barron</i>	117
Technological Lock-In <i>T J Foxon</i>	123
Technology and Environmental Policy <i>R Kemp and S Pontoglio</i>	128
Non-Renewable Fossil/Nuclear/Electricity Markets	137
Coal: Prospects in the Twenty-First Century: Exhaustion Trumped by Global Warming? <i>R L Gordon</i>	137
Economics of Peak Oil <i>S P Holland</i>	146
Green Microaccounting for Oil Extraction <i>R D Cairns</i>	151
Modeling Reserve Growth in Natural Gas Fields <i>E D Attanasi</i>	156
Natural Gas Networks <i>K T Midthun, V S Nørstebo, A Tomasgard, and A S Werner</i>	161
Price Dynamics in Domestic Energy Markets <i>G M Dempster and J P Isaacs</i>	168
Renewable/Alternative Energy	173
Economic Implications of Wind Power Intermittency <i>N Boccard</i>	173
Economics of Biofuels: An Overview <i>T Lundgren and P-O Marklund</i>	184
Economics of Technology Learning in Wind Power <i>K Ek and P Söderholm</i>	188
Economics of Wind Power: An Introduction <i>P Söderholm</i>	195
Hydropower Economics: An Overview <i>F R Førsund</i>	200
Measuring the Environmental Externalities of Offshore Wind Power: The Case of Visual Disamenities <i>J Ladenburg</i>	209
Measuring the Environmental Externalities of Onshore Wind Power <i>A Bergmann</i>	213

Residential Energy Demand	218
<i>B Krström</i>	

VOLUME 2

RESOURCES

Media Non-Biological	1
Economics of Exploration for and Production of Exhaustible Resources	1
<i>J Swierzbinski</i>	
Economics of Groundwater	10
<i>J A Roumasset and C A Wada</i>	
Economics of Market Power in the Extraction of Nonrenewable Resources	22
<i>U Chakravorty and M Liski</i>	
Theory and Practice of Fisheries and Water Economics	31
<i>R Q Grafton and D Squires</i>	
Media: Biological	39
Economics and Ecology of Open-Access Fisheries	39
<i>K Fuller, D Kling, K Kroetz, N Ross, and J N Sanchirico</i>	
Economics of Agricultural Residuals and Overfertilization: Chemical Fertilizer Use, Livestock Waste, Manure Management, and Environmental Impacts	50
<i>R Innes</i>	
Economics of Pest Control	58
<i>M J Livingston</i>	
Hunting and Exploitation of Terrestrial Animal Species	68
<i>A Skonhøft</i>	
Reducing Emissions from Deforestation and Forest Degradation	78
<i>H J Albers and E J Z Robinson</i>	
Microeconomics	87
Economic Analysis of Forest Products Markets	87
<i>D M Adams and C A Montgomery</i>	
Forest Management and Climate Change	97
<i>R J Alig</i>	
Joint Production of Good and Bad Outputs with a Network Application	109
<i>R Färe, S Grosskopf, and C Pasurka</i>	
Spatial Management of Renewable Natural Resources	119
<i>H J Albers</i>	
Voluntary Resource Conservation and Environmental Management in Agriculture and Forestry	124
<i>D E Ervin</i>	
Policy Tools	133
Conservation Easements: Tools for Conserving and Enhancing Ecosystem Services	133
<i>D P Parker and W N Thurman</i>	
Deforestation and Forest Degradation: Concerns, Causes, Policies, and Their Impacts	144
<i>A Pfaff, G S Amacher, E O Sills, M J Coren, C Streck, and K Lawlor</i>	

Exclusive Economic Zone <i>R Hannesson</i>	150
Externality Regulation in Oil and Gas <i>J R Boyce</i>	154
Fishery Cooperatives as a Management Institution <i>R T Deacon and D A Ovando</i>	169
Forest Taxation <i>P Gong and K-G Löfgren</i>	176
Individual Transferable Quotas in Fisheries <i>R Amason</i>	183
International Trade and the Conservation of Renewable Resources <i>C Fischer</i>	192
Land Use Policies in the United States for Protecting Biodiversity and Ecosystem Services <i>M Walls and A Riddle</i>	200
Protecting Marine Ecosystems in Fishery Regulation <i>J K Abbott and D S Holland</i>	206
Regulated Open Access and Regulated Restricted Access Fisheries <i>M N Reimer and J E Wilen</i>	215
Taxation of Nonrenewable Resources <i>D Lund</i>	224
Territorial Use Rights in Fisheries (TURFs) <i>A Doerr, S Cardenas, S Jardine, H Yoon, S Bucaram, and J N Sanchirico</i>	232
Tree Plantations and Genetics in Forestry <i>R A Sedjo</i>	243
Water Crises, Water Rights, and Water Markets <i>T L Anderson, B Scarborough, and L R Watson</i>	248
Theoretical Tools	255
Carbon Leakage <i>C Di Maria, T O Michielsen, and E van der Werf</i>	255
Cartel-versus-Fringe Models <i>C Withagen</i>	260
Differential Games and Resources <i>N Van Long</i>	268
Diffusion and Spatial Aspects <i>A Xepapadeas</i>	277
Discounting <i>L Karp and C Traeger</i>	286
Experiments on Common Property Management <i>D van Soest</i>	293
Games and Resources <i>B Harstad and M Liski</i>	299
Green Paradox <i>R Gerlagh and T O Michielsen</i>	309

Hartwick's Rule <i>G B Asheim</i>	314
Optimal Control and Resources <i>M R Caputo</i>	321
Option Value and Precaution <i>C Gollier and N Treich</i>	332
Regime Shifts and Management <i>A-S Crépin, R Oonsie Biggs, S Polasky, M Troell, and A de Zeeuw</i>	339
Regime Shifts: Early Warnings <i>F Wagener</i>	349

VOLUME 3

ENVIRONMENT

Allocation Tools	1
Bayesian Decision Theory and Climate Change <i>K Keller</i>	1
Coasean Bargaining <i>T L Cherry, S Cotten, and J F Shogren</i>	5
Environmental and Natural Resource Economics: Decisions Under Risk and Uncertainty <i>W D Shaw</i>	10
Environmental Cost-Benefit Analysis <i>N Hanley</i>	17
Environmental Ethics for Environmental Economists <i>A Randall</i>	25
Ethics, Economics, and Decision Rules for Climate Change <i>R B Howarth</i>	33
Governance of Common-Pool Resources <i>M A Janssen</i>	38
Lindahl Pricing for Public Goods and Experimental Auctions for the Environment <i>E C Smith and S K Swallow</i>	45
Managing Catastrophic Risk <i>H Kunreuther and G Heal</i>	52
Optimization Across Space <i>A W Ando</i>	60
Payments for Ecosystem Services: Mechanisms to Achieve Desired Landscape Patterns <i>G M Parkhurst</i>	68
Property Rights and the Environment <i>J M Duke</i>	75
Media	81
Agricultural Sources of Water Pollution <i>J B Braden and J S Shortle</i>	81
Economics of Pesticide Use and Regulation <i>E Lichtenberg</i>	86

Hazardous Substances	98
<i>S L Stafford</i>	
Local/Regional Air Pollution from Stationary Sources	103
<i>A M Bento</i>	
Waste Disposal and Recycling	109
<i>T C Kinnaman</i>	
Water Pollution from Industrial Sources	114
<i>D Earnhart</i>	
Water Pollution from Oil Spills	121
<i>M A Cohen</i>	
Wetlands and Coastal Estuaries	127
<i>E B Barbier</i>	
Policies/Incentives	133
Deposit-Refund Systems in Practice and Theory	133
<i>M Walls</i>	
Ecolabeling	138
<i>R L Hicks</i>	
Economics of Nonpoint Pollution	143
<i>J S Shortle and J B Braden</i>	
Enforcement	150
<i>J K Stranlund</i>	
European Union's Emissions Trading System	155
<i>C Böhringer and A Lange</i>	
Green Tax Design in the Real (Second-Best) World	161
<i>I Parry</i>	
Information Programs	169
<i>J P Shimshack</i>	
Liability Rules and the Environment	174
<i>R Innes</i>	
Price Instruments	185
<i>K Segerson</i>	
Prices versus Quantities	193
<i>T Requate</i>	
Quantity Instruments	204
<i>J Rubin and S Siriwardena</i>	
SO ₂ Program	212
<i>D Burtraw and M Goulder</i>	
Standards	217
<i>G E Helfand</i>	
Superfund Program	222
<i>K A Kiel</i>	
Voluntary Approaches to Environmental Protection	226
<i>M Khanna and K Brouhle</i>	

Political Economy	235
Contest Models and Environmental Policy <i>A Heyes and C Liston-Heyes</i>	235
Democracy, Political Institutions, and Environmental Policy <i>P G Fredriksson and J R Wollscheid</i>	245
Empirical Methods for Political Economy Analyses of Environmental Policy <i>D L Millimet</i>	250
Environmental Conflict and Natural Resources <i>L Hotte</i>	261
Environmental Federalism: Empirics <i>N D Woods</i>	271
Environmental Justice: The Experience of the United States <i>H S Banzhaf</i>	278
Lobbying, Voting, and Environmental Policy: Theory <i>Y-B Lai</i>	282
Political Economy and the Interaction Between International Trade and Environmental Policies <i>S Gulati and D Kellenberg</i>	288
Political Economy of Instrument Choice <i>T S Aidt</i>	296
Political Economy of International Environmental Agreements <i>J-C Altamirano-Cabrera, L Wangler, H-P Weikard, and S Kroll</i>	300
Public Acceptability of Incentive-Based Mechanisms <i>S Kallbekken</i>	306
Strategic Environmental Policy <i>M Greaker</i>	313
Valuation Tools	321
Averting Behavior <i>M Dickie</i>	321
Benefit Transfer <i>R S Rosenberger and R J Johnston</i>	327
Contingent Valuation Method <i>J C Whitehead and T C Haab</i>	334
Hedonics <i>L O Taylor</i>	342
Travel Cost Methods <i>G R Parsons</i>	349
Value of a Statistical Life <i>T J Kniesner and J D Leeth</i>	359
<i>Index</i>	369

Para tener acceso completo a este libro usted debe solicitarlo de manera formal a la Coordinación del Programa de Doctorado Interinstitucional en Ciencias Ambientales mediante el **Formato de Préstamo Bibliográfico** (descargar formato) y remitirlo al siguiente correo: **dicambientales@unicauca.edu.co**



DOCTORADO INTERINSTITUCIONAL EN
CIENCIAS AMBIENTALES

