



A QUARTERLY JOURNAL FOR DEBATING ENERGY ISSUES AND POLICIES

Electricity is in ferment – an unusual state for an industry which has traditionally enjoyed the security of long-term assets, steadily growing demand, and stable revenues (which has, in short, long been the position of a typical utility). These secure foundations are now coming into question as the industry faces major technological, economic, and institutional change. Perhaps most visible are the developments in electricity generation – the growing penetration of intermittent renewable plants, driven both by technological advances and by the policy commitment to decarbonization. But significant shifts are also taking place elsewhere in the system with the rapid development of information and control technology, which is opening the way for new approaches to system management and more flexible demand. It is likely that we are only seeing the beginnings of these changes – they raise wider questions about the very nature of the industry's product and its relationship with its customers.

The technological developments have been accompanied by major policy and economic changes – falling electricity demand, greater use of on-site generation leading to lower network income, governments rather than markets driving investment in both renewable and fossil generation, and

so on. The institutional frameworks surrounding the industry are struggling to keep up. For two decades or so after 1990, governments across the world focused on liberalization and the extension of market forces; now there is a new emphasis on decarbonization, but governments have not yet worked out whether decarbonization and liberalization can go hand in hand or whether there is a fundamental conflict. Markets have also been slow to adapt to the new era – the industry has traditionally relied on marginal cost (kWh) pricing, although a large proportion of its costs have always been fixed (and some eminent economists like Ronald Coase have argued against the over-emphasis on marginal cost). With a growing penetration of zero marginal cost plants, the marginal cost approach looks increasingly outdated, whether at wholesale or retail level. Regulation too needs to respond to the changes – including the increasing decentralization of the system – under way. New coordination and control methods may be required to manage the rapid growth of intermittent generation, particularly wind. Indeed the whole basis of the industry's workings is coming into question: what ultimately are its products? How should it price them? What business models should the industry be developing? What are

## CONTENTS

### Transformation of the Electricity Sector: Technology, Policy and Business Models

Future business models for power markets: what can we learn from the 'sharing economy'?	Rolando Fuentes	5
How the 'Big Beyond' will change business models of utilities	Christoph Burger and Jens Weinmann	8
Renewable integration and the changing requirement of grid management in the twenty-first century	Rahmat Poudineh	11
Market integration with energy-only markets and renewables: lessons of experience from Australia	Rabindra Nepal and Tooraj Jamasb	14
Reforming European electricity markets for renewables	Richard Green and Goran Strbac	17
Supporting renewable generation in the UK	David M. Newbery	19
Centralized or decentralized? Remove first the regulatory barriers	Ignacio Pérez-Arriaga and Scott Burger	22
Wind power and electricity supply security in Colombia	David Harbord, David Robinson, and Iván M. Giraldo	26
Decarbonization through electrification – the importance of energy taxation being in line with long-term energy policy	Graham Weale	29
View from the USA: rapid transformation of power sector calls for new tariffs	Fereidoon P. Sioshansi	33
A comparison of US and EU electricity prices: the relevance of the government wedge	David Robinson	35
Assessment of demand response in Shanghai	Malcolm Keay, Xin Li, and David Robinson	40
Power system reform to enable large-scale wind utilization in China	Zhang Xiliang and Xiong Weiming	43



## CONTRIBUTORS TO THIS ISSUE

**Christoph Burger** is a faculty member at the European School of Management and Technology (ESMT), Berlin

**Scott Burger** is a doctoral student at the MIT Institute for Data, Systems and Society

**Rolando Fuentes** is Research Fellow, King Abdullah Petroleum Studies and Research Center (KAPSARC), Riyadh

**Iván Mario Giraldo** is Economist, Senior Associate (Latin America) at Market Analysis Ltd

**Richard Green** is Professor of Sustainable Energy Business at the Business School, Imperial College, London

**David Harbord** is Director at Market Analysis Ltd

**Tooraj Jamasb** is Chair in Energy Economics at Durham University Business School, Durham

**Malcolm Keay** is a senior research fellow at the Oxford Institute for Energy Studies

**Rabindra Nepal** is a lecturer in Economics at CDU Business School, Charles Darwin University, Darwin, Australia

**David M. Newbery** is Director of the Energy Policy Research Group at Cambridge University

**Ignacio Pérez-Arriaga** is Visiting Professor at the Sloan School of Management (MIT) and Professor at Comillas University and the European University Institute in Florence

**Rahmat Poudineh** is lead research fellow for the electricity programme, Oxford Institute for Energy Studies, Oxford

**David Robinson** is a senior research fellow at the Oxford Institute for Energy Studies and President, David Robinson & Associates

**Fereidoon P. Sioshansi** is President of Menlo Energy Economics, California

**Goran Strbac** is Chair in Electrical Energy Systems at the Department of Electrical and Electronic Engineering, Imperial College, London

**Graham Weale** is Chief Economist at RWE AG, Essen

**Jens Weinmann** is Programme Director at the European School of Management and Technology (ESMT), Berlin

**Xin Li** is a research fellow at the Oxford Institute for Energy Studies

**Xiong Weiming** is a doctoral student at the Institute of Energy, Environment and Economy, Tsinghua University

**Zhang Xiliang** is Professor of Energy Economics and Policy at the Institute of Energy, Environment and Economy, Tsinghua University

*The views expressed in this issue are solely those of the authors and do not necessarily represent the views of OIES, its members, or any other organization or company.*

## NEW OIES PUBLICATIONS

### Recently published book

*Europe's Long Energy Journey – Towards an Energy Union*

by David Buchan and Malcolm Keay

February 2016

### Recent Research Papers

*Under the Mountains – Kurdish Oil and Regional Politics*

by Robin Mills

January 2016

*Electricity Markets are Broken – Can they be Fixed?*

by Malcolm Keay

January 2016

*Fiscal Stabilization in Oil and Gas Contracts – Evidence and Implications*

by Mario Mansour and Carole Nakhle

January 2016

*The Evolution of European Traded Gas Hubs*

Patrick Heather

December 2015

### Recent Energy Comments

*Gazprom – Is 2016 the Year for a Change of Pricing Strategy in Europe?*

by James Henderson

January 2016

*Incidence and Impact – A Disaggregated Poverty Analysis of Fossil Fuel Subsidy Reform*

by Jun Rentschler

December 2015

*Reforming Electricity Reforms? Empirical Evidence from Asian Economies*

by Anupama Sen, Rabindra Nepal, and

Tooraj Jamasb

February 2016

*Natural Gas in China – A Regional Analysis*

by Xin Li

November 2015

*A Holistic Framework for the Study of Interdependence Between Electricity and Gas Sectors*

by Donna Peng and Rahmat Poudineh

November 2015

*Has the North Sea Entered a Late-life Crisis?*

by Virendra Chauhan, Maarten van

Mourik, and Amrita Sen

December 2015

*US Shale Oil Dynamics in a Low Price Environment*

by Trisha Curtis

November 2015

*Oil in Uganda – Hard Bargaining and Complex Politics in East Africa*

by Luke Patey

October 2015

*The Dynamics of the Revenue Maximization – Market Share Trade-off: Saudi Arabia's Oil Policy in the 2014–2015 Price Fall*

by Bassam Fattouh, Rahmat Poudineh,

and Anupama Sen

October 2015

*The New Economics of Oil*

by Spencer Dale

October 2015



THE OXFORD  
INSTITUTE  
FOR ENERGY  
STUDIES

A RECOGNIZED INDEPENDENT CENTRE OF THE UNIVERSITY OF OXFORD



57 Woodstock Road Oxford OX2 6FA

**Direct Line:** +44 (0)1865 889136

**Reception:** +44 (0)1865 311377

**Fax:** +44 (0)1865 310527

[www.oxfordenergy.org](http://www.oxfordenergy.org)

EDITOR: **Bassam Fattouh**

CO-EDITORS: **Rahmat Poudineh, David Robinson, and Malcolm Keay**

Annual Subscription (four issues) £90.00

Oxford Energy Forum. ISSN 0959-7727. Published by Oxford Institute for Energy Studies, Registered Charity 286084.

© Oxford Institute for Energy Studies, 2016.