

This study was prepared by the *World Energy Outlook (WEO)* team in the Directorate of Sustainability, Technology and Outlooks (STO) in co-operation with other directorates and offices of the Agency. The study was designed and directed by **Laura Cozzi**, Head of the *WEO* Energy Demand Outlook Division, and **Tim Gould**, Head of the *WEO* Energy Supply Outlook Division. The focus on China's energy outlook was co-ordinated by **Timur Gül** (also lead on environment and demand modelling) and **Kieran McNamara** (also contributed to renewables and energy efficiency). The focus on natural gas was co-ordinated by **Christophe McGlade** (also lead on oil) and **Johannes Trüby** (also lead on coal; contributed to China). **Elie Bellevrat** was co-lead on end-use modelling (also contributed to China and renewables and energy efficiency) with **Stéphanie Bouckaert** (also lead on renewables and energy efficiency), **Paweł Olejarnik** was lead on oil, natural gas and coal supply modelling, and **Brent Wanner** was lead on power (contributed to China and energy access). Principal contributors to the report were: **Zakia Adam** (co-lead on data management and lead on agriculture; contributed to fossil-fuel subsidies), **Ali Al-Saffar** (co-lead on Southeast Asia¹), **An Qi** (China), **Ruben Bibas** (China), **Tord Bjørndal** (natural gas), **Jean Chateau** (China), **Olivia Chen** (energy access and environment), **Ian Cronshaw** (natural gas, power and China), **Hannah Daly** (co-lead on energy access², lead on services sector), **Davide D'Ambrosio** (co-lead on data management; contributed to power and access), **Vincenzo Franza** (lead on renewables subsidies; contributed to power), **Timothy Goodson** (renewables and energy efficiency, power), **Paul Hugues** (lead on transport), **Kim Tae-Yoon** (lead on petrochemicals, oil refining and trade; contributed to China), **Markus Klingbeil** (natural gas), **Law Gee Yong** (energy access and power), **Ulises Neri Flores** (China), **Claudia Pavarini** (power and environment), **Toshiyuki Shirai** (co-lead on Southeast Asia, lead on fossil-fuel subsidies), **Bianka Shoai-Tehrani** (environment), **Molly A. Walton** (co-lead on energy access), **Kira West** (industry, China, renewables and energy efficiency), **David Wilkinson** (power and China) and **Xia Ting** (China). **Yasmine Arsalane**, **Simon Bennett**, **Christian Besson**, **Laila El-Ashmawy**, **Francesco Fuso Nerini**, **Han Mei**, **Apostolos Petropoulos**, **Andrew Prag**, **Maria Sobron Bernal** and **Glenn Sondak** also contributed to the report. **Teresa Coon** and **Eleni Tsoukala** provided essential support.

Edmund Hosker and **Robert Priddle** carried editorial responsibilities.

Kamel Ben Naceur, Director of STO, and David Turk, Acting Director of STO, provided guidance throughout the project. The China focus benefited from input from Yang Lei from the Economics and Investment Office, Kevin Tu, David Bénazéraf, and Lyu Zhong from the IEA China desk, Luis Munuera from the Energy Technology Policy Division, Emmanouil Christinakis (formerly of the IEA's Energy Data Centre) and Liu Yunhui from

1. *Southeast Asia Energy Outlook 2017* was launched in Singapore on 24 October 2017. It is available to download at: www.iea.org/southeastasia.

2. *Energy Access Outlook: from Poverty to Prosperity* was launched in Rome, Italy on 19 October 2017. It is available to download at: www.iea.org/energyaccess.

the Gas, Coal and Power Markets Division. Marine Gorner from the Energy Technology Policy Division contributed to the analysis on transport. Peter Janoska and Jean-Baptiste Le Marois from the Energy Environment Division contributed to the analysis on environment. Yasmina Abdelilah, Heymi Bahar and Ute Collier from the Renewable Energy Division, and Joseph Ritchie and Louise Vickery from the Energy Efficiency Division contributed to the renewables and energy efficiency analysis.

Valuable comments and feedback were provided by the senior management and several colleagues within the IEA. In particular, Paul Simons, Keisuke Sadamori, Rebecca Gaghen, Duncan Millard, Laszlo Varro, Christian Zinglersen, Amos Bromhead, Neil Atkinson, Niels Berghout, Thomas Berly, Alessandro Blasi, Toril Bosoni, John Dulac, Araceli Fernandez Pales, Carlos Fernandez Alvarez, Peter Fraser, Christina Hood, Juho Lipponen, Samantha McCulloch, Brian Motherway, Bruce Murphy, Kristine Petrosyan, Uwe Remme, Céline Rouquette, Tristan Stanley, Cecilia Tam, Aad Van Bohemen, Michael Waldron and Aya Yoshida. The Energy Data Centre provided support and assistance throughout the preparation of the report.

Thanks go to the IEA's Communication and Information Office for their help in producing the final report, particularly Astrid Dumond for production and to Bertrand Sadin for graphics. Diana Perillaud provided essential support to the peer review process. Lorcan Lyons also contributed to graphics and the website. Debra Justus was the copy-editor.

Li Xiang and Wang Shuli (IEA China Liaison Office), Markus Amann, Peter Rafaj, Janusz Cofala, Gregor Kiesewetter, Wolfgang Schöpp, Chris Heyes, Zbigniew Klimont, Jens Borken-Kleefeld (International Institute for Applied Systems Analysis), Kang Seungwoo (MINES ParisTech, Paris), Paul Balcombe (Imperial College London, United Kingdom) and Per Magnus Nysveen (Rystad Energy) provided valuable input to the analysis.

The work could not have been achieved without the support and co-operation provided by many government bodies, organisations and companies worldwide, notably: Ministry of Economy, Trade and Industry, Japan; European Commission; Secretaría de Energía, Mexico; New Zealand Ministry of Foreign Affairs and Trade; Energy Market Authority, Singapore; Government of Sweden; Center for Strategic and International Studies, United States; China Renewable Energy Engineering Institute; ClimateWorks Foundation; Energy Research Institute, National Development and Reform Commission, China; Environmental Defense Fund, United States; The Research Council of Norway; The Research Institute of Innovative Technology for the Earth, Japan; Gas and Oil Technologies Collaboration Programme; GE Power; Oil and Gas Climate Initiative; BHP Billiton; Chevron; Enel; Eni; Royal Dutch Shell; Schneider Electric; Statoil; and Toshiba. Special thanks also go to the companies that participated in the activities of the IEA Energy Business Council (EBC) during 2017 as these generated valuable inputs to this study.

A number of workshops and meetings were organised to get input to this study. The participants offered valuable new insights, feedback and data for this analysis.

- Technical workshop on methane emissions, Paris, 2 February 2017.
- Roundtable Meeting on China's Energy Outlook, Beijing, 16 February 2017.

- 5th IEA Unconventional Gas Forum, organised with the Centre for Coal Seam Gas and the Energy Initiative at The University of Queensland, Brisbane, 24 February 2017.
- High-level Workshop on Energy and Development, Paris, 27 March 2017.
- High-level Workshop on the Strategic Role of Natural Gas, organised with the Center for Strategic and International Studies, Washington, D.C., 5 May 2017.

Further details on these events are at: www.iea.org/workshops and www.iea.org/ugforum.

Peer reviewers

Many senior government officials and international experts provided input and reviewed preliminary drafts of the report. Their comments and suggestions were of great value. They include:

Bojana Achovski	Gas Infrastructure Europe
Keigo Akimoto	The Research Institute of Innovative Technology for the Earth, Japan
Venkatachalam Anbumozhi	Economic Research Institute for ASEAN and East Asia
John Appleby	Natural Resources Canada
Paul Appleby	BP
Doug Arent	National Renewable Energy Laboratory, United States
Peter Bach	Danish Energy Agency
Rangan Banerjee	Indian institute of Technology Bombay
Richard Baron	European Climate Foundation
Marco Baroni	Independent consultant
Paul Baruya	IEA Clean Coal Centre
Christopher Beaton	International Institute for Sustainable Development
Peter Betts	Department for Business, Energy and Industrial Strategy, United Kingdom
Peter Birch Sørensen	University of Copenhagen, Denmark
Paul Bjacek	Accenture
Tomas Björnsson	Vattenfall
Bob Blain	Natural Resources Canada
Kornelis Blok	Ecofys
Rina Bohle Zeller	Vestas
Teun Bokhoven	Consolair
Jason Bordoff	Columbia University, United States
Jean-Paul Bouttes	EDF
Albert Bressand	Rijksuniversiteit Groningen and Columbia Center for Sustainable Investment
Mark Brownstein	Environmental Defense Fund, United States
David Buckrell	Ministry of Business, Innovation and Employment, New Zealand
Sara Budinis	Imperial College London, United Kingdom
Mick Buffier	Glencore
Jane Burston	National Physical Laboratory, United Kingdom

Nick Butler	Independent consultant
Guy Caruso	Center for Strategic and International Studies, United States
Xavier Chen	Statoil China
Sergej Chetvergov	Lukoil
Rebecca Collyer	European Climate Foundation
Emanuela Colombo	Politecnico di Milano, Italy
Stefan Corbett	Ministry of Business, Innovation and Employment, New Zealand
Jostein Dahl Karlsen	Ministry of Petroleum, Norway
David Darling	Department of Natural Resources Canada
Gilles De Noblet	Schlumberger
Marc Debever	EDF
Jos Dehaeseleer	Marcogaz
Jos Delbeke	DG Climate Action, European Commission
Nicole Delloero	Areva
Rob Dellink	OECD
Philippine De-Tserclaes	Schneider Electric
James Diamond	Government of Canada
Pedro Dias	Solar Heat Europe
Giles Dickson	WindEurope
Daniel Dorner	HM Treasury, United Kingdom
Duan Hongxia	International Institute for Sustainable Development
Jean Baptiste Dubreuil	Engie
Adeline Duterque	Engie
Jane Olga Ebinger	Sustainable Energy for All
Neal Elliott	American Council for an Energy-Efficient Economy, United States
Masana Ezawa	Ministry of Economy, Trade and Industry, Japan
Nikki Fisher	Anglo American
Justin Flood	Sunset Power International
Pamela Franklin	United States Environmental Protection Agency
Peter Freyberg	Glencore
Fu Sha	National Center for Climate Strategy and International Cooperation, China
Mike Fulwood	Nexant
Rosanna Fusco	Eni
Ashwin Gambhir	Prayas (Energy Group), India
Andrew Garnett	University of Queensland, Australia
Carlos Gascó Travesedo	Iberdrola
Francesco Gattei	Eni
Dolf Gielen	International Renewable Energy Agency
Jens Goebel	Eni Trading and Shipping
David Goldwyn	Atlantic Council, United States
Andrii Gritsevskiy	International Atomic Energy Agency

Han Wenke	Energy Research Institute, National Development and Reform Commission, China
Roy Hartstein	Southwestern Energy
David Hawkins	Natural Resources Defense Council, United States
He Bing	Natural Resources Canada
Harald Hecking	EWI Energy Research and Scenarios
Darren Hempel	Department of Natural Resources Canada
James Henderson	Oxford Institute for Energy Studies, United Kingdom
Doug Hengel	German Marshall Fund of the United States
Masazumi Hirono	Tokyo Gas
Neil Hirst	Imperial College London, United Kingdom
Lena Höglund-Isaksson	International Institute for Applied Systems Analysis
Takashi Hongo	Mitsui Global Strategic Studies Institute, Japan
Jean-Charles Hourcade	Centre International de Recherche sur l'Environnement et le Développement
Didier Houssin	IFP Energies Nouvelles, France
Tom Howes	DG Energy, European Commission
Hu Zhaoguang	State Grid Energy Research Institute, China
Esa Hyvarinen	Fortum
Anil K. Jain	NITI Aayog, India
James Jensen	Jensen Associates
Jan-Hein Jesse	JOSCO Energy Finance and Strategy Consultancy
James Jewell	Department of Energy, United States
Jiang Kejun	Energy Research Institute, National Development and Reform Commission, China
Jing Chunmei	China Center for International Economic Exchanges
Kevin Johnsen	Nordic Energy Research
Marianne Kah	ConocoPhillips
Tom Kerr	International Finance Corporation
Fabian Kęsicki	E.ON
David Knapp	Energy Intelligence Group
Hans Jørgen Koch	Nordic Energy Research
Paweł Konzal	Chevron
Ken Koyama	Institute of Energy Economics, Japan
Atsuhito Kurozumi	Japan Economic Research Institute, Development Bank of Japan
Vello Kuuskraa	Advanced Resources International
Marc-André Lafrance	Environment and Climate Change Canada
Benoit Lebot	International Partnership for Energy Efficiency Cooperation
Lei Xianzhang	State Grid Corporation of China
Steve Lennon	Shanduan
Kaili Levesque	Department of Natural Resources Canada
Li Jingfeng	Shenhua Group
Li Lailai	World Resources Institute

Li Yan	Greenpeace East Asia
Li Yao	SIA Energy, China
Clarissa Lins	Catavento Consultancy, Brazil
Liu Qiang	National Center for Climate Strategy and International Cooperation, China
Liu Wenge	China Coal Information Institute
Liu Xiaoli	Energy Research Institute, National Development and Reform Commission, China
Antonio Lopez Rodriguez	Repsol
Kjetil Lund	Statkraft
Ma Linwei	Tsinghua BP Center, China
Joan MacNaughton	The Climate Group / Energy Academy of Europe
Nick Markwell	Ministry of Business, Innovation and Employment, New Zealand
Takeshi Matsushita	Mitsubishi Corporation
Felix Christian Matthes	Öko-Institut - Institute for Applied Ecology, Germany
Pedro Antonio Merino García	Repsol
Laura Merrill	International Institute for Sustainable Development
Bert Metz	European Climate Foundation
Cristobal Miller	Department of Natural Resources Canada
Tatiana Mitrova	Energy Research Institute of the Russian Academy of Sciences
Simone Mori	Enel
Peter Morris	Minerals Council of Australia
Gerard Moutet	Oil and Gas Climate Initiative
Isabel Murray	Department of Natural Resources Canada
Steve Nadel	American Council for an Energy-Efficient Economy, United States
Chris Namovicz	Energy Information Administration, United States
Fernando Naredo	Westinghouse Electric Company
Drew Nelson	Environmental Defense Fund, United States
Joachim Nick-Leptin	Federal Ministry for Economic Affairs and Energy, Germany
Stefan Nowak	IEA TCP on Photovoltaic Power Systems Programme
Thomas Nowak	European Heat Pump Association
Steven Oliver	Department of Environment and Energy, Australia
Todd Onderdonk	ExxonMobil
Henri Paillere	OECD Nuclear Energy Agency
Pak Yongduk	Korea Energy Economics Institute
Michael Paunescu	Department of Natural Resources Canada
Brian Pearce	International Air Transport Association
Kate Penney	Department of Industry and Science, Australia
Volkmar Pflug	Siemens
Antonio Pflüger	Federal Ministry for Economic Affairs and Energy, Germany
Stephan Plisson-Saune	Total

Brigitte Poot	Total
Pierre Porot	IFP Energies Nouvelles, France
Lynn Price	Lawrence Berkeley National Laboratory, United States
Amanda Pugliese	Natural Resources Canada
Valérie Quiniou-Ramus	Total
Mark Radka	UN Environment Programme
Veerabhadran Ramanathan	University of California San Diego, United States
Prakash Rao	Lawrence Berkeley National Laboratory, United States
Stine Leth Rasmussen	Danish Energy Association
Anil Razdan	Former Ministry of Petroleum and Natural Gas, India
Nicola Rega	Confederation of European Paper Industries
Gustav Resch	Vienna University of Technology, Austria
Christoph Richter	Solarway
Seth Roberts	Dow Chemical
Joeri Rogelj	International Institute for Applied Systems Analysis
Hans-Holger Rogner	International Institute for Applied Systems Analysis
Konstantin Romanov	Gazprom
Vineet Saini	Ministry of Science and Technology, India
Carlos Salle Alonso	Iberdrola
Kaare Sandholt	National Renewable Energy Centre, China
Stijn Santen	CO ₂ -Net
Stephanie Saunier	Carbon Limits
Steve Sawyer	Global Wind Energy Council
Hans-Wilhelm Schiffer	Coal Industry Advisory Board
Sandro Schmidt	Federal Institut for Geosciences and Natural Resources, Germany
Martin Schöpe	Federal Ministry for Economic Affairs and Energy, Germany
Shan Baoguo	State Grid Energy Research Institute, China
Adnan Shihab-Eldin	Foundation for the Advancement of Sciences, Kuwait
Steve Shim	SK Group
Shruti Shukla	Global Wind Energy Council
Maria Sicilia Salvadores	Enagas
Adam Sieminski	Center for Strategic and International Studies, United States
Pierre Sigonney	Total
Katia Simeonova	United Nations Framework Convention on Climate Change
Stephan Singer	Climate Action Network International
Robert Siveter	Former IPIECA
Rob Smith	Department of Energy, United States
Christopher Snary	Department for Business, Energy and Industrial Strategy, United Kingdom
Svend Søyland	Nordic Energy Research
Dale Spencer	BP
James Steel	Department for Business, Energy and Industrial Strategy, United Kingdom

Jonathan Stern	Oxford Institute for Energy Studies, United Kingdom
Ulrik Stridbaek	Ørsted
Phil Swanson	Climate and Clean Air Coalition
Emanuele Taibi	International Renewable Energy Agency
Minoru Takada	United Nations Department of Economic and Social Affairs
Kuniharu Takemata	Electric Power Development Co. (J POWER)
Yasuo Tanabe	Hitachi
Kazushige Tanaka	Ministry of Economy, Trade and Industry, Japan
Mark Taylor	Alberta Energy Regulator, Canada
Frauke Thies	Smart Energy Demand Coalition
Wim Thomas	Royal Dutch Shell
Tian Zhiyu	Energy Research Institute, National Development and Reform Commission, China
Dennis Trigylidas	Department of Natural Resources Canada
Sergey Tverdokhle	Siberian Coal Energy Co.
Fridtjof Unander	Research Council of Norway
Noé van Hulst	Permanent Representation of the Kingdom of the Netherlands to the OECD
Tom van Ierland	DG Climate Action, European Commission
Maarten van Werkhoven	IEA TCP on Energy-Efficient End-Use Equipment
Stefaan Vergote	DG Environment, European Commission
Pierre Verlinden	Trina Solar
Frank Verrastro	Center for Strategic and International Studies, United States
Elisabetta Vignati	Joint Research Centre, European Commission
Eirik Waerness	Statoil
Andrew Walker	Cheniere
Wang Zhen	China National Petroleum Corporation
Graham Weale	Ruhr Uni Bochum
Paul Welford	Hess Corporation
John Westerheide	General Electric
Peter Westerheide	BASF
Steve Winberg	Batelle
Arthur Yan	BP China
Yuan Jing	Energy Foundation China
Anthony Yuen	Citigroup
Zhang Qi	China University of Petroleum
William Zimmern	BP
Anna Zyzniewski	Department of Natural Resources Canada

The individuals and organisations that contributed to this study are not responsible for any opinions or judgments it contains. All errors and omissions are solely the responsibility of the IEA.