This study, a cross-agency effort, was prepared by the World Energy Outlook team in co-operation with all divisions in the Directorate of Sustainability, Technology and Outlooks, the Strategic Initiatives Office and the Directorate of Energy Markets and Sustainability. The study was designed and directed by Laura Cozzi, Chief Energy Modeller.

The lead authors and co-ordinators were: Christophe McGlade and Daniel Wetzel. Daniel Crow, Blandine Barreau and Davide D’Ambrosio were also part of the core group. Laszlo Varro, Chief Economist, provided essential guidance. The International Monetary Fund, in particular Benjamin Hunt and Keiko Honjo, partnered with the IEA to provide the macroeconomic analysis.

The other main authors were: Zakia Adam (subsidies and data support), Yasmine Arsalane (power), Heymi Bahar (renewables), Stéphanie Bouckaert (modelling co-ordination), Arthur Conjetian (access), Elisabetta Cornago (transport), Amrita Dasgupta (transport), Connor Donovan (power), Musa Erdogan (industry), Araceli Fernandez Pales (innovation lead), Timothy Goodson (buildings lead), Maxine Jordan (buildings), Vanessa Koh (power), Kevin Lane (buildings), Pharoah Le Feuvre (biofuels), Lilly Lee (transport), Olivier Lejeune (macro analysis), Sara Moarif (context), Samantha McCulloch (innovation), Kieran McNamara (grids), Ariane Millot (buildings), Sarbojit Pal (transport), Leonardo Paoli (transport), Sebastian Papapanagiotou (grids), Claudia Pavarin (power), Daniele Perugia (grids), Apostolos Petropoulos (transport lead), Alison Pridmore (urban infrastructure), Uwe Remme (innovation), Arnaud Rouget (access), Hugo Salamanca (industry), Andreas Schroeder (industry lead), Leonie Staas (jobs), Brent Wanner (power lead).

The study also relied on support from across the entire World Energy Outlook team. Teresa Coon and Eleni Tsoukala provided essential support.

Edmund Hosker carried editorial responsibility. Debra Justus was the copy-editor.

Valuable comments and feedback were provided by other senior management and numerous other colleagues within the IEA. In particular Mechthild Wörsdörfer, Keisuke Sadamori, Alessandro Blasi, Joel Couse, Paolo Frankl, Peter Fraser, Rebecca Gaghen, Tim Gould, Timur Gül, Brian Motherway, Masatoshi Sugiiura, Lucila Arboleya Sarazola and Peter Janoska.

Thanks go to the IEA’s Communication and Digitalisation Office for their help in producing the report and website materials, particularly to Jad Mouawad, Jethro Mullen, Astrid Dumond, Christopher Gully, Isabelle Nonain-Semelin, Julie Puech and Therese Walsh. Diana Browne provided essential support to the production process. IEA’s Office of the Legal Counsel, Office of Management and Administration and Energy Data Centre provided assistance throughout the preparation of the report.

We are grateful for the guidance and valuable advice of Peter Betts on climate issues. Valuable input to the analysis was provided by David Wilkinson (independent consultant).
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; and Ministry of the Environment, Land and Sea, Italy on smart grids and power system modernisation. Activities within the IEA Clean Energy Technologies Programme provided valuable support to this report.

A webinar and an online consultation was held at the end of March 2020 in which participants offered valuable insights, feedback and data for this analysis. We are grateful for their input.

A number of senior government officials and international experts provided input and reviewed preliminary report drafts. Comments and suggestions that were of great value for the report were received from:

Lydia Shawel Abebe  World Health Organization (WHO)
Angeline Afanoukoe  Nexans
Doug Arent  US National Renewable Energy Laboratory (NREL)
Jason Babik  Westinghouse
Georg Baeu ml  Volkswagen
Richard Baron  2050 Pathways Platform
Jim Barrett  Barrett Economics
Harmeet Bawa  ABB Power Grids
Sama Bilbao y Leon  Nuclear Energy Agency (NEA)
Rina Bohle Zeller  Vestas, Denmark
Jason Bordoff  Columbia University, United States
Nils Borg  European Council for an Energy Efficient Economy
Alex Bowen  London School of Economics and Political Science
William Brent  Power for All
Sam Brock  American Wind Energy Association
Mark Brownstein  Environmental Defense Fund, United States
Simon Buckle  Organisation for Economic Co-operation and Development (OECD)
Nick Butler  Kings College London
Sally Cairns  University of Leeds
Ben Caldecott  University of Oxford
Julie Cammell  Global Off-Grid Lighting Association
Pantelis Capros  E3Modelling
Anne-Sophie Cerisola  United Nations
Russel Conklin  US Department of Energy
Beth Copanas  RES
Paula Coussy  IFP Energies Nouvelles
Francois Dassa  EDF
Brian Dassa  Sustainable Energy for All

IEA. All rights reserved
Acknowledgements

Nicolas Di Sbroiavacca  
Fundación Bariloche

Navroz Dubash  
Centre for Policy Research, India

Candice El-Asmar  
Permanent Delegation of Australia to the OECD

David Elzinga  
Asian Development Bank

Normant Emmanuel  
Saint-Gobain

Alex Evans  
Global LPG Partnership

Olivier Fontan  
Haut Conseil pour le Climat, France

James Foster  
UK Department for Business, Energy and Industrial Strategy

Christopher Frey  
ENERCON

Jean-François Gagné  
Department of Natural Resources Canada

Faith Gan  
Energy Market Authority, Singapore

Peter George  
Clean Cooking Alliance

Michael Ghielmetti  
ABB

Arunabha Ghosh  
Council on Energy, Environment and Water, India

Dolf Gielen  
International Renewable Energy Agency (IRENA)

Peter Gornischeff  
Permanent Representation of Estonia to the OECD and UNESCO

Michael Grubb  
University College London

Stéphane Hallegatte  
The World Bank

Atle Harby  
Sintef

Antoine Herzog  
EDF

Christina Hood  
Compass Climate

Frank Jotzo  
Australian National University

Michael Kelly  
World LPG Association

Fabian Kesicki  
E.ON SE

Hoseok Kim  
Korea Environment Institute

Tomasz Kozluk  
OECD

Jochen Kreusel  
T&D Europe

Vedantha Kumar  
UK Department for Business, Energy and Industrial Strategy

Bharadwaj Kummamuru  
World Bioenergy Association

Michał Kurtyka  
Minister of Climate, Poland

Rodolfo Lacy  
OECD

Carole Lancereau  
Ministry for the Ecological and Inclusive Transition, France

Joyce Lee  
Global Wind Energy Council

Aaron Leopold  
African Mini-Grid Association

Karan Mangotra  
The Energy and Resources Institute (TERI)

Michael Mavrovouniotis  
Wellspring Climate Initiative

Espen Mehlum  
World Economic Forum

Bert Metz  
European Climate Foundation

Axel Michaelowa  
University of Zurich / Perspectives Climate Change

Vincent Minier  
Schneider Electric

Acknowledgements
<table>
<thead>
<tr>
<th>Name</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simone Mori</td>
<td>ENEL</td>
</tr>
<tr>
<td>Luis Mundaca</td>
<td>Lund University</td>
</tr>
<tr>
<td>Clay Nesler</td>
<td>Johnson Controls</td>
</tr>
<tr>
<td>Sarah Neumann</td>
<td>Federal Ministry for Climate Action Environment</td>
</tr>
<tr>
<td></td>
<td>Mobility Innovation and Technology, Austria</td>
</tr>
<tr>
<td>Patrick Oliva</td>
<td>Paris Process on Mobility and Climate</td>
</tr>
<tr>
<td>Koen Peters</td>
<td>GOGLA (Global association for the off-grid solar</td>
</tr>
<tr>
<td></td>
<td>energy industry)</td>
</tr>
<tr>
<td>Volkmar Pflug</td>
<td>Siemens</td>
</tr>
<tr>
<td>Ivan Pineda</td>
<td>WindEurope</td>
</tr>
<tr>
<td>Michael Pollitt</td>
<td>University of Cambridge</td>
</tr>
<tr>
<td>Lynn Price</td>
<td>US Lawrence Berkeley National Laboratory</td>
</tr>
<tr>
<td>Michael Renner</td>
<td>International Renewable Energy Agency (IRENA)</td>
</tr>
<tr>
<td>Rasmus Nicolas Ringgaard</td>
<td>Permanent Delegation of Denmark to the OECD</td>
</tr>
<tr>
<td>Seth Roberts</td>
<td>Saudi Aramco</td>
</tr>
<tr>
<td>Nick Robins</td>
<td>London School of Economics and Political Science</td>
</tr>
<tr>
<td>Karen Roiy</td>
<td>Danfoss</td>
</tr>
<tr>
<td>Raffaele Rossi</td>
<td>Solar Power Europegeo</td>
</tr>
<tr>
<td>Catherine Saget</td>
<td>International Labour Organization</td>
</tr>
<tr>
<td>Yamina Saheb</td>
<td>OpenEXP</td>
</tr>
<tr>
<td>Carlos Salle Alonso</td>
<td>Iberdrola</td>
</tr>
<tr>
<td>Roberto Schaeffer</td>
<td>Universidade Federal do Rio de Janeiro, Brazil</td>
</tr>
<tr>
<td>Joachim Schmitz</td>
<td>Federal Ministry for Economic Affairs and Energy,</td>
</tr>
<tr>
<td></td>
<td>Germany</td>
</tr>
<tr>
<td>Rob Schwiers</td>
<td>Chevron</td>
</tr>
<tr>
<td>Simon Sharpe</td>
<td>UK Cabinet Office</td>
</tr>
<tr>
<td>Adnan Shihab Eldin</td>
<td>Foundation for the Advancement of Sciences, Kuwait</td>
</tr>
<tr>
<td>Maria Sicilia</td>
<td>ENAGAS</td>
</tr>
<tr>
<td>Jim Skea</td>
<td>Intergovernmental Panel on Climate Change (IPCC)</td>
</tr>
<tr>
<td></td>
<td>Working Group III Co-Chair</td>
</tr>
<tr>
<td>Ottavia Stella</td>
<td>ENI</td>
</tr>
<tr>
<td>Ivan Torre</td>
<td>The World Bank</td>
</tr>
<tr>
<td>Matteo Trascinelli</td>
<td>ABB</td>
</tr>
<tr>
<td>Diana Ürge-Vorsatz</td>
<td>Central European University</td>
</tr>
<tr>
<td>Frank van der Vleuten</td>
<td>Ministry of Foreign Affairs, The Netherlands</td>
</tr>
<tr>
<td>Willem Tom Van Ierland</td>
<td>DG Climate Action, European Commission</td>
</tr>
<tr>
<td>Jean-Pascal van Ypersele</td>
<td>Université Catholique de Louvain, Belgium</td>
</tr>
<tr>
<td>Christelle Verstraeten</td>
<td>ChargePoint</td>
</tr>
<tr>
<td>David Victor</td>
<td>UC San Diego School of Global Policy and Strategy,</td>
</tr>
<tr>
<td></td>
<td>United States</td>
</tr>
<tr>
<td>Salvatore Vinci</td>
<td>World Health Organization (WHO)</td>
</tr>
<tr>
<td>Doug Vine</td>
<td>Center for Climate and Energy Solutions (C2ES)</td>
</tr>
</tbody>
</table>
Acknowledgements

Jeff Waller  ENGIE Impact
Wang Yanjia  Tsinghua University
Wang Yao  International Institute Green Finance
Peter Wooders  International Institute for Sustainable Development (IISD)
Akira Yabumoto  J-POWER
Kyota Yamamoto  Ministry of Economy Trade and Industry, Japan
Mel Ydreos  International Gas Union
Kandeh Yumkella  Former UN Under-Secretary General and first CEO of Sustainable Energy for All

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

This document and any map included herein are without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.