BP Energy Outlook
2017 edition

Spencer Dale
Group chief economist

bp.com/energyoutlook
#BPstats
Economic backdrop

Contributions to GDP growth by factor

<table>
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<th>Period</th>
<th>Productivity</th>
<th>Population</th>
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<tr>
<td>1975-1995</td>
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<td>1995-2015</td>
<td>4%</td>
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<tr>
<td>2015-2035</td>
<td>5%</td>
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OECD, China, India, Africa, Other

Contributions to GDP growth by region

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<th>China</th>
<th>India</th>
<th>Africa</th>
<th>Other</th>
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Global energy demand

Energy consumption by region

Billion toe

- Other
- Africa
- Other non-OECD Asia
- India
- China
- OECD

Growth in GDP and primary energy

% per annum

- Energy intensity
- GDP
- Primary energy

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Primary energy consumption by fuel

Billion toe

*Renewables includes wind, solar, geothermal, biomass, and biofuels

Shares of primary energy

*Renewables*
China’s declining dependency on coal

Coal consumption growth by region

Shares of primary energy in China

Billion toe

OECD
Other non-OECD Asia
India
China
Other
Total

1965-1975
1975-1985
1985-1995
1995-2005
2005-2015
2015-2025
2025-2035

1.5
1.0
0.5
0.0
-0.5

1975
1985
1995
2005
2015
2025
2035

80%
70%
60%
50%
40%
30%
20%
10%
0%

Coal
Oil
Non-fossil
Gas

2017 Energy Outlook

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Fuel mix

Primary energy consumption by fuel

Shares of primary energy

*Renewables includes wind, solar, geothermal, biomass, and biofuels

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Renewables

Renewables as a share of power generation

Shares of renewable power growth

- EU
- US
- World
- China

- 1995-2015
- 2015-2035

- China
- OECD Asia
- India
- Africa
Key features of the energy outlook

• Global energy demand continues to grow, driven by the burgeoning Asian middle class

• The fuel mix gradually decarbonizes with non-fossil fuels providing almost half of the increase in primary energy

• The global economy continues to electrify, with the power sector playing an ever-increasing role in shaping the energy transition
Oil

• How might electric cars and the broader mobility revolution affect oil demand?

• How might the abundance of oil resources affect the behaviour of low-cost oil producers?
Oil demand

Liquids demand

Liquids demand growth

Liquids includes oil, biofuels and derivatives of coal and natural gas.
Growth of electric cars

The global car fleet: 2015-2035

Billions of vehicles

- Electric cars
- Conventional cars
- Non-OECD
- OECD

2015

2035

By region

By type

Illustrative path for battery pack costs

$/kWh

0

50

100

150

200

250

2015

2020

2025

2030

2035

Battery pack costs*

Range of estimates of cost parity between electric and oil-powered cars

*For a Battery Electric Vehicle with a 60 kWh pack. Cost projections depend heavily on the degree of EV uptake, which is uncertain, so ranges should be treated as illustrative only. Current estimates of battery costs also vary widely, but this uncertainty is not shown.
Liquid fuel demand from cars

Decomposing changes in liquids demand from cars: 2015-2035

- Growth in demand for travel: 23 Mb/d
- Gains in fuel efficiency: 17 Mb/d
- Switching to natural gas vehicles: 0.2 Mb/d
- Switching to electric vehicles: 1.2 Mb/d
- 2035 demand: 23 Mb/d
Mobility revolution

- **Electric cars**: lead to a switch away from conventional cars
- **Autonomous vehicles**: improve fuel efficiency via efficient driving
- **Car sharing**: can amplify the effects of new-technology cars
- **Ride pooling**: reduce total miles driven by pooling journeys
Mobility revolution scenarios

Digital revolution:
Impact on oil demand in cars in 2035

Electric revolution:
Impact on oil demand in cars in 2035
Oil

- How might electric cars and the broader mobility revolution affect oil demand?
- How might the abundance of oil resources affect the behaviour of low-cost oil producers?
Abundance of oil resources

Estimates of technically recoverable resources and cumulative oil demand

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<th>Region</th>
<th>2015-2035 (Trillion barrels)</th>
<th>2015-2050 (Trillion barrels)</th>
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<td>Asia</td>
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<td>Africa</td>
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<td>S&amp;C America</td>
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<td>N America</td>
<td>1.6</td>
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<td>CIS</td>
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<td>Middle East</td>
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Cumulative demand

- Middle East
- CIS
- S&C America
- N America
- Africa
- Asia
- Europe

Oil supply of lower-cost producers

- Low-cost producer’s share of global liquids production (right axis)
- Share
  - 65%
  - 60%
  - 55%
  - 50%
  - 45%
  - 40%

- Middle East OPEC
- Russia
- US
Natural gas

Gas supply growth: 2015-2035

Shale
Conventional decline
Conventional growth

Australia
Russia
Middle East

Other
Africa
China
US

Gas consumption by sector

Transport
Buildings
Power
Non-combusted
Industry

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2017 Energy Outlook
Growth of LNG

LNG supply

LNG demand

Bcf/d

Other
Russia
Africa
United States
Australia
Qatar

Bcf/d

Other
Middle East
S&C America
Asia
Europe

1990
2005
2020
2035

VCMStudy.ir
LNG Trade

Net LNG exports and imports in 2035 (Bcf/d)

North America

Europe

Middle East

Other Asia

Russia

Australia

S & C America

Africa

Exports
Imports

22

17

9

44

5

2

7

17

2017 Energy Outlook
Carbon emissions
Carbon emissions

Contributions to slower growth of carbon emissions

% per annum

- 2.5%
- 2.0%
- 1.5%
- 1.0%
- 0.5%
- 0.0%

1995-2015

- GDP
- Energy intensity
- Fuel mix

2015-2035

Carbon emissions

Billion tonnes CO₂

- IEA 450
- Base case

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**Faster transition pathways**

**Carbon emissions**

- **Base case**
- **Faster transition**

**Reductions in emissions versus base case**

- **Power**
- **CCUS***
- **Industry & Buildings**
- **Transport**

*Carbon capture, use and storage (predominantly in power sector)
Faster transition pathways

Carbon emissions

Reductions in emissions versus base case

Billion tonnes CO$_2$ in 2035

- Power
- CCUS*
- Industry & Buildings
- Transport

*Carbon capture, use and storage (predominantly in power sector)
Energy outlook under alternative transition pathways

Annual demand growth by fuel

The changing fuel mix

2015

Base

FT

EFT

1995-2015

2015-35

Mtoe per annum

-150

-100

-50

0

50

100

150

200

250

Non-fossil

Coal

Gas

Oil

Total

% of primary energy

2015

Base

FT

EFT

2035

Oil

Coal

Gas

Non-fossil
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</tr>
<tr>
<td>Oil &amp; gas</td>
<td>51%</td>
<td>48%</td>
<td>48%</td>
<td>46%</td>
<td>51%</td>
<td>39%</td>
</tr>
<tr>
<td>Renewables</td>
<td>16%</td>
<td>23%</td>
<td>17%</td>
<td>29%</td>
<td>19%</td>
<td>38%</td>
</tr>
<tr>
<td><strong>Share of abatement vs 2015</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Power sector</td>
<td>&gt;100%</td>
<td>89%</td>
<td>77%</td>
<td>74%</td>
<td>58%</td>
<td>35%</td>
</tr>
</tbody>
</table>
Risks to gas demand

Global primary energy shares

- Base case
- Slower gas case

Coal

Gas

Natural gas growth 2015-2035

- Slower gas case
- Base case
- Faster transition
- Even faster transition

Increasing climate and environmental policies

Mtoe per annum

% of primary energy

10% 15% 20% 25% 30% 35% 40%


Coal

Gas

2017 Energy Outlook