International Energy Outlook 2016

For
Center on Global Energy Policy
Columbia University
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By
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Key findings in the IEO2016 Reference case

• World energy consumption increases from 549 quadrillion Btu in 2012 to 629 quadrillion Btu in 2020 and then to 815 quadrillion Btu in 2040, a 48% increase (1.4%/year). Non-OECD Asia (including China and India) account for more than half of the increase.

• The industrial sector continues to account for the largest share of delivered energy consumption; the world industrial sector still consumes over half of global delivered energy in 2040.

• Renewable energy is the world’s fastest-growing energy source, increasing by 2.6%/year; nuclear energy grows by 2.3%/year, from 4% of the global total in 2012 to 6% in 2040.

• Fossil fuels continue to supply more than three-fourths of world energy use in 2040.
Key findings in the IEO2016 Reference case (continued)

• Among the fossil fuels, natural gas grows the fastest. Coal use plateaus in the mid-term as China shifts from energy-intensive industries to services and worldwide policies to limit coal use intensify. By 2030, natural gas surpasses coal as the world’s second largest energy source.

• In 2012, coal provided 40% of the world’s total net electricity generation. By 2040, coal, natural gas, and renewable energy sources provide roughly equal shares (28-29%) of world generation.

• With current policies and regulations, worldwide energy-related carbon dioxide emissions rise from about 32 billion metric tons in 2012 to 36 billion metric tons in 2020 and then to 43 billion metric tons in 2040, a 34% increase.
Many global issues increase uncertainty…

• Economic growth in key economies (China, Brazil, Russia, among others)
• Implementation and strength of climate policies
• Technology improvement rates (both supply and demand)
• Unrest in oil producing countries
• OPEC production
• Future of nuclear generating capacity
Global outlook
Economic activity and population drive increases in energy use; energy intensity (E/GDP) improvements moderate this trend

average annual percent change (2012–40)

percent per year

Renewables grow fastest, coal use plateaus, natural gas surpasses coal by 2030, and oil maintains its leading share

world energy consumption in quadrillion Btu

As total energy consumption grows, shares by end-use sector remain relatively unchanged

world delivered energy consumption by end-use sector
quadrillion Btu

Economic growth drives electricity demand; electricity use grows at a faster rate than other delivered energy, but slower than GDP

world GDP and net electricity generation
percent growth (rolling average of 3-year periods)

Non-OECD nations drive the increase in total energy use

World energy consumption (quadrillion Btu)

<table>
<thead>
<tr>
<th>Year</th>
<th>History</th>
<th>2012</th>
<th>Projections</th>
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<tbody>
<tr>
<td>1990</td>
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<td>2000</td>
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<td>2010</td>
<td>43%</td>
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Share of total energy:
- Non-OECD: 57%
- OECD: 43%
- Non-OECD: 65%
- OECD: 35%

Non-OECD Asia accounts for 55% of the world increase in energy use

Projected carbon intensity of energy use (CO2/E) declines through 2040 in both OECD and non-OECD; non-OECD CO2/E rose over 2000–12

carbon intensity of energy consumption, 1990-2040
kilograms CO2 per million Btu

Liquid fuels markets
Most of the growth in world oil consumption occurs in the non-OECD regions — especially Asia

world petroleum and other liquid fuels consumption
million barrels per day

Passenger-miles per person will rise as GDP per capita grows; travel growth is largely outside the OECD

passenger-miles per capita (left-axis) and GDP per capita (horizontal-axis) for selected country groupings 2010–40

Liquid fuels supplies from both OPEC and non-OPEC producers increase through 2040

The largest components of other liquid fuels are NGPL, refinery gain, and biofuels.

Natural gas markets
Non-OECD nations will account for 76% of the growth in natural gas consumption

world natural gas consumption
trillion cubic feet

Non-OECD Asia, Middle East, and OECD Americas account for the largest increases in natural gas production

world change in natural gas production, 2012–40

trillion cubic feet

Shale gas, tight gas, and coalbed methane will become increasingly important to gas supplies, not only for the U.S., but also China and Canada.

Natural gas production by type, trillion cubic feet:

### China
- **2012:**
  - Shale gas: 2
  - Tight gas: 2
  - Coalbed methane: 2
  - Other gas: 2
- **2040:**
  - Shale gas: 30
  - Tight gas: 20
  - Coalbed methane: 20
  - Other gas: 20

### Canada
- **2012:**
  - Shale gas: 2
  - Tight gas: 2
  - Coalbed methane: 2
  - Other gas: 2
- **2040:**
  - Shale gas: 30
  - Tight gas: 20
  - Coalbed methane: 20
  - Other gas: 20

### United States
- **2012:**
  - Shale gas: 30
  - Tight gas: 20
  - Coalbed methane: 20
  - Other gas: 20
- **2040:**
  - Shale gas: 30
  - Tight gas: 20
  - Coalbed methane: 20
  - Other gas: 20

**Note:** Other natural gas includes natural gas produced from structural and stratigraphic traps (e.g. reservoirs), historically referred to as ‘conventional’ production.

**Source:** EIA, International Energy Outlook 2016
Electricity markets
GDP drives electricity demand growth, but the electricity growth rate compared to the GDP growth rate becomes smaller over time.
Renewables, natural gas, and coal all contribute roughly the same amount of global net electricity generation in 2040.

Wind and hydropower each account for one third of the increase in renewable generation; solar is fastest-growing (8.3%/year)

Virtually all of the growth in nuclear power will occur in the non-OECD regions; China accounts for 61% of world nuclear capacity growth.

Energy-related carbon dioxide emissions
Coal remains the world’s largest source of energy-related CO2 emissions, but by 2040 its share declines to 38%.

World energy-related carbon dioxide emissions (billion metric tons)

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Of the world’s three largest coal consumers, only India is projected to continue to increase throughout the projection.

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Coal consumption in the US, China, and India

Quadrillion Btu

Non-OECD Asia will account for about 60% of the world increase in energy-related CO2 emissions

world energy-related carbon dioxide emissions
billion metric tons

For more information

Annual Energy Outlook | www.eia.gov/aeo

Short-Term Energy Outlook | www.eia.gov/steo

International Energy Outlook | www.eia.gov/ieo

Monthly Energy Review | www.eia.gov/mer

Today in Energy | www.eia.gov/todayinenergy

State Energy Profiles | www.eia.gov/state

Drilling Productivity Report | www.eia.gov/petroleum/drilling/

International Energy Portal | www.eia.gov/beta/international/?src=home-b1

Angelina LaRose, Center on Global Energy Policy
June 16, 2016
Supplementary Slides
Growth in OPEC production comes mainly from the Middle East

OPEC crude and lease condensate production
million barrels per day

Increases to non-OPEC oil supplies outside the United States are primarily from Brazil, Russia, Canada, and Kazakhstan.

non-OPEC crude and lease condensate production in selected country groupings

million barrels per day

Liquefaction capacity additions over the 2015-19 time period will increase global capacity by over 30%

Note: Capacity additions in 2015-19 include projects currently under construction, and represent nameplate capacity, not adjusted for ramp-up

Source: U.S. Energy Information Administration estimates based on trade press
Geographically, the scale and fuel mix of renewable generation in 2040 varies widely

renewable net electricity generation by selected country and country grouping, 2040 billion kilowatthours