The Big Picture: An Overview of Energy Use and Supply

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by
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Director, Office of Integrated and International Energy Analysis
Major takeaways

Based on EIA’s Reference case projections to 2040 in the Annual Energy Outlook 2015 and International Energy Outlook 2013 that generally reflect current policies, including final regulations and the sunset of tax credits under current law:

United States

• With reliance on fossil fuels, U.S. energy consumption grows modestly with reductions in energy intensity resulting from improved technologies and trends driven by existing laws and regulations – notably in transportation

• U.S. energy production grows substantially – led by increasing shale gas and tight oil production – that contributes to lower reliance on energy imports

• Renewables provide an increased share of electricity generation, reflecting rising long-term natural gas prices and the high capital costs of new coal and nuclear generation capacity

• Improved efficiency of energy consumption in end-use sectors and a shift away from more carbon-intensive fuels help to stabilize U.S. energy-related carbon dioxide (CO₂) emissions, which remain below the 2005 level through 2040
Major takeaways (continued)

World View

• World energy consumption increases well over 50 percent. Half of the increase is attributed to China and India
• Electric power generation nearly doubles
• Renewable energy and nuclear power are the world’s fastest-growing energy sources; however, fossil fuels continue to supply almost 80 percent of world energy use through 2040
• Natural gas is the fastest growing fossil fuel in the outlook. Coal grows faster than liquid fuel consumption until after 2030, mostly due to increases in China’s consumption of coal and tepid growth in liquids demand attributed to slow growth in the OECD and high sustained oil prices
• The industrial sector accounts for the largest share of delivered energy consumption, consuming over half of global delivered energy in 2040
• Worldwide energy-related CO₂ emissions increase around 15 percent by 2020 and 45 percent by 2040 from about 31 billion metric tons in 2010
Comparative metrics for energy

- One Btu is approximately equal to the energy released in the burning of a wood match

- **A quadrillion Btu** is $10^{15}$ Btu

- One quadrillion Btu is equal to 172 million barrels of crude oil

- One quadrillion Btu is equal to 500,000 100-ton railroad cars of coal

- A **trillion cubic feet (tcf)** of natural gas equals 1.03 quadrillion Btu

- A **trillion kilowatthours** of electricity equal 3.1 quadrillion Btu

- A **million barrels of oil per day over a year** is equal to 2.1 quadrillion Btu
United States
Reductions in energy intensity largely offset impact of GDP growth, leading to slow projected growth in energy use

U.S. primary energy consumption
quadrillion Btu

History

2013

Projections


120

100

80

60

40

20

0

Renewables (excluding liquid biofuels)

Natural gas

Coal

Nuclear

Petroleum and other liquids

36%

18%

8%

1%

35%

19%

8%

1%

33%

10%

8%

8%

1%

Source: EIA, Annual Energy Outlook 2015 Reference case
Most of U.S. energy use occurs in industry and transportation with major demands for electricity in the buildings and industrial sectors.

U.S. primary energy consumption
quadrillion Btu

<table>
<thead>
<tr>
<th>Year</th>
<th>History</th>
<th>2013</th>
<th>Projections</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>41%</td>
<td>32%</td>
<td>36%</td>
</tr>
<tr>
<td>1985</td>
<td>20%</td>
<td>18%</td>
<td>20%</td>
</tr>
<tr>
<td>1990</td>
<td>14%</td>
<td>22%</td>
<td>20%</td>
</tr>
<tr>
<td>1995</td>
<td>25%</td>
<td>28%</td>
<td>25%</td>
</tr>
<tr>
<td>2000</td>
<td>25%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2005</td>
<td>25%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>28%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2020</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2025</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2030</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2035</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2040</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: EIA, Annual Energy Outlook 2015 Reference case

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In the transportation sector, motor gasoline use declines; diesel fuel, jet fuel, and natural gas use grow.
Shale resources remain the dominant source of U.S. natural gas production growth

U.S. dry natural gas production
trillion cubic feet

Source: EIA, Annual Energy Outlook 2015 Reference case
Combination of increased tight oil production and higher fuel efficiency drive projected decline in oil imports

U.S. liquid fuels supply
million barrels per day

Note: “Other” includes refinery gain, biofuels production, all stock withdrawals, and other domestic sources of liquid fuels
Source: EIA, Annual Energy Outlook 2015 Reference case
Over time the electricity mix gradually shifts to lower-carbon options, led by growth in renewables and gas-fired generation.

source: EIA, Annual Energy Outlook 2015 Reference case
Non-hydro renewable generation grows to double hydropower generation by 2040

renewable electricity generation by fuel type
billion kilowatthours

Source: EIA, Annual Energy Outlook 2015 Reference case

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Energy-related CO₂ emissions are sensitive to the influence of future economic growth and energy price trends on energy consumption.

![Graph showing energy-related carbon dioxide emissions over time.](image)

Source: EIA, Annual Energy Outlook 2015
World View
World energy consumption increases by well over 50 percent

Energy consumption
Quadrillion Btu

Source: EIA, International Energy Outlook 2013
Renewable energy and nuclear power are the fastest growing source of energy consumption.
World petroleum and other liquid fuels are primarily from crude oil and lease condensate with notable amount of natural gas plant liquids.

- Crude oil and lease condensate
- Refinery processing gain
- Natural gas plant liquids
- Biofuels
- Gas-to-liquids
- Coal-to-liquids


*Ethane, liquefied petroleum gases (propane, normal butane, and isobutane), and natural gasoline separated from natural gas at natural gas processing, fractionating, and cycling plants.
Transportation uses most of the world’s petroleum and other liquid fuels

petroleum and other liquids consumption
quadrillion Btu

Source: EIA, International Energy Outlook 2013

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The industrial sector uses most of the world’s delivered energy from a variety of energy sources.

Industrial sector delivered energy consumption

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>2010 Quadrillion Btu</th>
<th>2040 Quadrillion Btu</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renewables</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electricity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natural gas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liquids</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>300</td>
<td>300</td>
</tr>
</tbody>
</table>

Source: EIA, International Energy Outlook 2013
Three countries account for the bulk of world coal consumption that continues to grow.

Source: EIA, International Energy Outlook 2013
Natural gas grows largely to serve growing electric and industrial demands

Source: EIA, International Energy Outlook 2013

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World electricity generation nearly doubles

net electricity generation
trillion kilowatthours

Source: EIA, International Energy Outlook 2013

Health Effects Institute, May 3, 2015
World energy-related CO₂ emissions increase around 45 percent

Source: EIA, International Energy Outlook 2013
China and India
By 2040, China’s energy use will be double the U.S. level; India’s a little more than half despite its faster GDP growth.
Transportation energy use per person projected to remain much less in China and India relative to United States and Europe

transportation primary energy consumption
million Btu per person

United States
OECD Europe
China
India

Source: EIA, International Energy Outlook 2013

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China’s industrial sector delivered energy consumption is driven by coal and electricity use

industrial delivered energy consumption
quadrillion Btu

Source: EIA, International Energy Outlook 2013
China’s coal consumption mainly serves both the electric power and industrial sectors

Source: EIA, International Energy Outlook 2013
There are many issues that increase uncertainty…

- Slower economic growth in China and other key economies (Brazil, Russia, among others)
- Unforeseen technological changes
- U.S. tight oil production in low world oil price environment
- Continued unrest in the Middle East and North Africa, and the potential for unrest elsewhere
- Mexican energy reform
- Sanctions and Russia
- OPEC production profile decisions
- Timing and extent of Iran’s return to oil export market in light of negotiations
- Climate and other policies
Major takeaways

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**United States**

- With reliance on fossil fuels, U.S. energy consumption grows modestly with reductions in energy intensity resulting from improved technologies and trends driven by existing laws and regulations – notably in transportation
- U.S. energy production grows substantially – led by increasing shale gas and tight oil production – that contributes to lower reliance on energy imports
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For more information


Annual Energy Outlook | www.eia.gov/forecasts/aeo

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

International Energy Outlook | www.eia.gov/forecasts/ieo

Today In Energy | www.eia.gov/todayinenergy

Monthly Energy Review | www.eia.gov/totalenergy/data/monthly

State Energy Portal | www.eia.gov/state

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

• United States: EIA’s *Annual Energy Outlook 2015*

Reductions in energy intensity largely offset impact of GDP growth, leading to slow projected growth in energy use.

U.S. primary energy consumption (quadrillion Btu)

- Petroleum and other liquids
- Natural gas
- Coal
- Renewables (excluding hydropower)
- Nuclear
- Conventional hydroelectric power

Source: EIA, Annual Energy Outlook 2015 Reference case
Growth in wind and solar generation meets a significant portion of projected total electric load growth in all AEO2015 cases.

U.S. renewable generation in all sectors by fuel billion kilowatthours

Source: EIA, Annual Energy Outlook 2015
World residential sector delivered energy consumption by energy source, 2010-2040

residential sector delivered energy consumption
quadrillion Btu

Source: EIA, International Energy Outlook 2013

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India industrial sector delivered energy consumption by energy source, 2010 and 2040

industrial sector delivered energy consumption
quadrillion Btu

Source: EIA, International Energy Outlook 2013
## Top ten countries with technically recoverable shale resources

### Shale oil

<table>
<thead>
<tr>
<th>Rank</th>
<th>Country</th>
<th>Billion barrels</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Russia</td>
<td>75</td>
</tr>
<tr>
<td>2</td>
<td>United States</td>
<td>58</td>
</tr>
<tr>
<td>3</td>
<td>China</td>
<td>32</td>
</tr>
<tr>
<td>4</td>
<td>Argentina</td>
<td>27</td>
</tr>
<tr>
<td>5</td>
<td>Libya</td>
<td>26</td>
</tr>
<tr>
<td>6</td>
<td>Venezuela</td>
<td>13</td>
</tr>
<tr>
<td>7</td>
<td>Mexico</td>
<td>13</td>
</tr>
<tr>
<td>8</td>
<td>Pakistan</td>
<td>9</td>
</tr>
<tr>
<td>9</td>
<td>Canada</td>
<td>9</td>
</tr>
<tr>
<td>10</td>
<td>Indonesia</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td><strong>World total</strong></td>
<td><strong>345</strong></td>
</tr>
</tbody>
</table>

### Shale gas

<table>
<thead>
<tr>
<th>Rank</th>
<th>Country</th>
<th>Trillion cubic feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>China</td>
<td>1,115</td>
</tr>
<tr>
<td>2</td>
<td>Argentina</td>
<td>802</td>
</tr>
<tr>
<td>3</td>
<td>Algeria</td>
<td>707</td>
</tr>
<tr>
<td>4</td>
<td>United States</td>
<td>665</td>
</tr>
<tr>
<td>5</td>
<td>Canada</td>
<td>573</td>
</tr>
<tr>
<td>6</td>
<td>Mexico</td>
<td>545</td>
</tr>
<tr>
<td>7</td>
<td>Australia</td>
<td>437</td>
</tr>
<tr>
<td>8</td>
<td>South Africa</td>
<td>390</td>
</tr>
<tr>
<td>9</td>
<td>Russia</td>
<td>285</td>
</tr>
<tr>
<td>10</td>
<td>Brazil</td>
<td>245</td>
</tr>
<tr>
<td></td>
<td><strong>World total</strong></td>
<td><strong>7,299</strong></td>
</tr>
</tbody>
</table>

Source: United States: EIA and USGS; Other basins: ARI.

Note: ARI estimates U.S. shale oil resources at 48 billion barrels and U.S. shale gas resources at 1,161 trillion cubic feet.
World net electricity generation from nuclear power by region, 2010-2040

net electricity generation
trillion kilowatthours

Source: EIA, International Energy Outlook 2013

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Coal share of world energy consumption by sector, 2010, 2020, and 2040

Source: EIA, International Energy Outlook 2013
Natural gas plant liquids and biofuels account for most of the other liquid fuels

world production of selected other liquid fuels, Reference case
million barrels per day