

## **EMD Coal Committee Mid-Year Report**

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**November 28, 2017**

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# Coal Commodity Report

## Executive Summary

Coal is the second-largest energy commodity worldwide in terms of energy use, exceeded only by oil. Production from the top ten coal-producing countries in 2016 was 8,012.2 million short tons (MMst), or 7,268.6 million metric tons (MMt). These countries account for ~90% of the world's total coal production, with China being the top coal-producing and consuming country. The world's top ten coal-producing countries, in terms of decreasing production according to the Energy Information Administration, are: (1) China, (2) India, (3) United States, (4) Australia, (5) Indonesia, (6) Russia, (7) South Africa, (8) Germany, (9) Poland, and (10) Kazakhstan.

Worldwide coal consumption, projected to the year 2040, will only slightly rise with respect to 2015 levels. China will continue to be the largest consumer of coal (~73 quadrillion Btu [British Thermal Units]), although its coal consumption is expected to decline. In contrast, coal consumption in India is projected to increase by almost 3% per year, surpassing coal consumption in the United States.

Although natural gas continues to compete with coal as a source for electricity generation, coal still has a powerful influence on electricity prices worldwide, and coal plants are likely to remain price-setting power units for many countries. Consequently, future security of coal supply will be necessary to maintain stability in wholesale electricity prices. Metallurgical coal prices are also reduced in the global markets. Recent declines in U.S. coal exports are related to a decrease in world coal demand, depressed international coal prices, and greater coal production in other coal-exporting countries. Decreased U.S. coal production has resulted from competition from lower natural gas prices, increasingly strict federal regulations, and coal-plant retirements because of implementation of new air-quality and emission standards. U.S. coal production in 2016 was 740.5 MMst (671.8 MMt). This represents a 21.5% reduction from 2014. In addition, there was a decline of the productive capacity of U.S. coal mines by 8.6% from the years 2015 to 2016, with a concomitant decline in coal consumption by 8.4%. However, U.S. coal production in the first two quarters in 2017 was greater than that in the first two quarters of 2016, with Wyoming as the leading coal-producing state.

## Leading Coal-Producing Countries in 2016

China, India, and the United States were the top-three leading countries for coal production in 2016 (Table 1). Together, they account for two-thirds of the world's coal production, although India and China also depend on imported coal to meet total demand. China's increased demand is driven by electricity generation, as well as by increased manufacturing and infrastructure development. All three of these countries began to increase coal production in the first half of 2017 (The Energy Advocate, 2017). By the end of May, production had increased by 6%, compared to the same period in 2016. This was the result of several factors that include India's continued efforts to augment existing electrification, shifting energy markets in the United States, and energy-policy changes in China. Clean coal, defined as coal combustion with greenhouse-gas capture, continues to be an important component of China, India, and the United States' plans for future energy.

Country	2016 production (MMst)	2016 production (MMt)
China	3,574.2	3,242.5
India	780.0	707.6
United States	740.5	671.8
Australia	554.8	503.3
Indonesia	507.6	460.5
Russia	402.9	365.5
South Africa	283.2	256.9
Germany	193.6	175.6
Poland	144.3	130.9
Kazakhstan	107.9	97.9
Other Countries	723.2	656.1
Total	8,012.2	7,268.6

Table 1. The top-ten coal-producing countries in 2016. Data from the International Energy Agency (IEA). Reference: National Mining Association referenced in The National Mining Association (2017).

## **Future Worldwide Coal Production and Consumption**

Global coal production, projected to the year 2040, is expected to change only slightly, increasing by only 3% (Fig. 1). China, which designates almost all of its coal production for use within its own country, is projected to decrease coal production by 15% from 2015 to 2040, concurrent with decreased demand. However, India is projected to offset this trend in China by increasing its annual coal production as demand rises.

Worldwide coal consumption is projected to the year 2040 as only slightly rising with respect to 2015 levels (Fig. 2). China will continue to be the largest consumer of coal in 2040 (about 73 quadrillion Btu), although its coal consumption is expected to decline. In contrast, coal consumption in India is projected to increase by almost 3% per year, surpassing the United States.

Asia will remain the world's largest importer of coal (Fig. 3), whereas Australia and Indonesia are expected to be the largest exporters (Fig. 4). By 2040, Australia will provide 37% of the world's coal exports, followed by Indonesia at 28%. Coal consumption in OECD (Organization for Economic Cooperation and Development) countries is anticipated to decline by 0.6% per year because of increased reliance on natural gas and renewables, coupled with moderate electricity demand. Trade in metallurgical coal for steel production will gradually increase overall, reflecting increased industrial consumption in India.

### World coal production

billion short tons

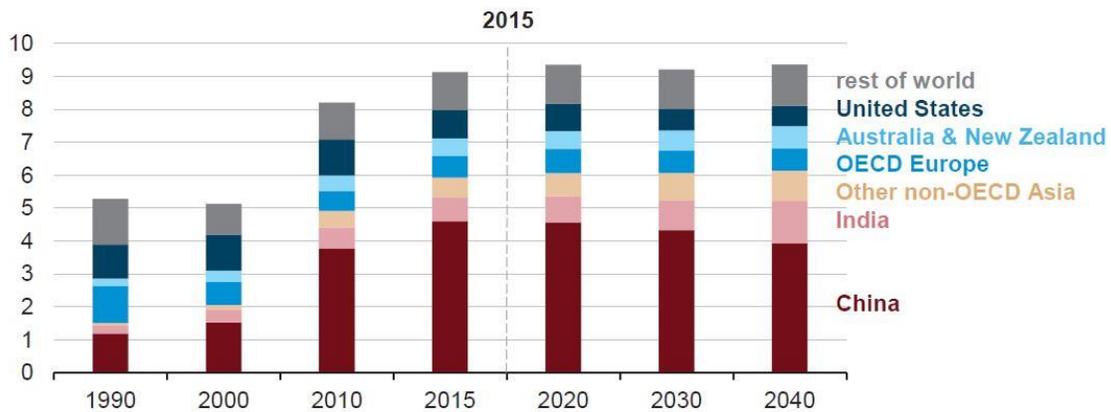


Figure 1. World coal production projected to 2040. Values are in billion short tons (Bst). From Energy Information Administration (2017a).

### World coal consumption

quadrillion Btu

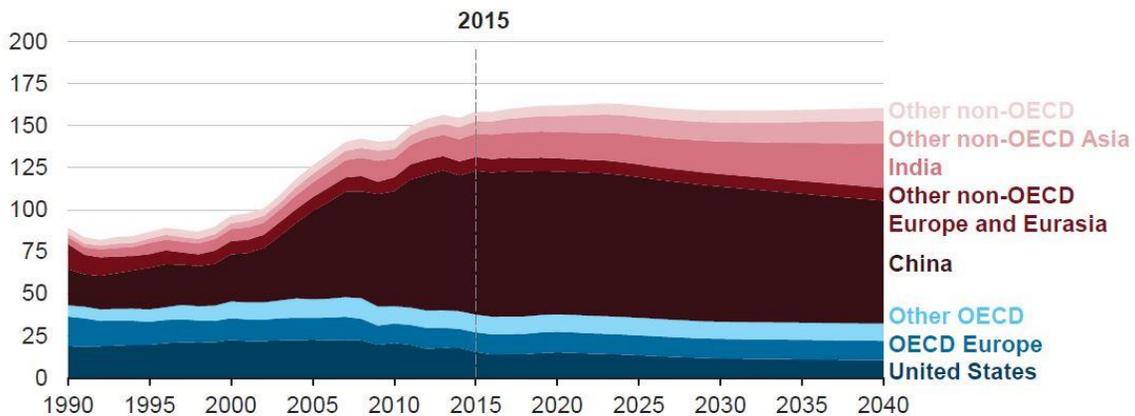


Figure 2. World coal consumption projected to 2040. Values are in quadrillion Btu (British Thermal Units). From Energy Information Administration (2017a).

## Coal imports billion short tons

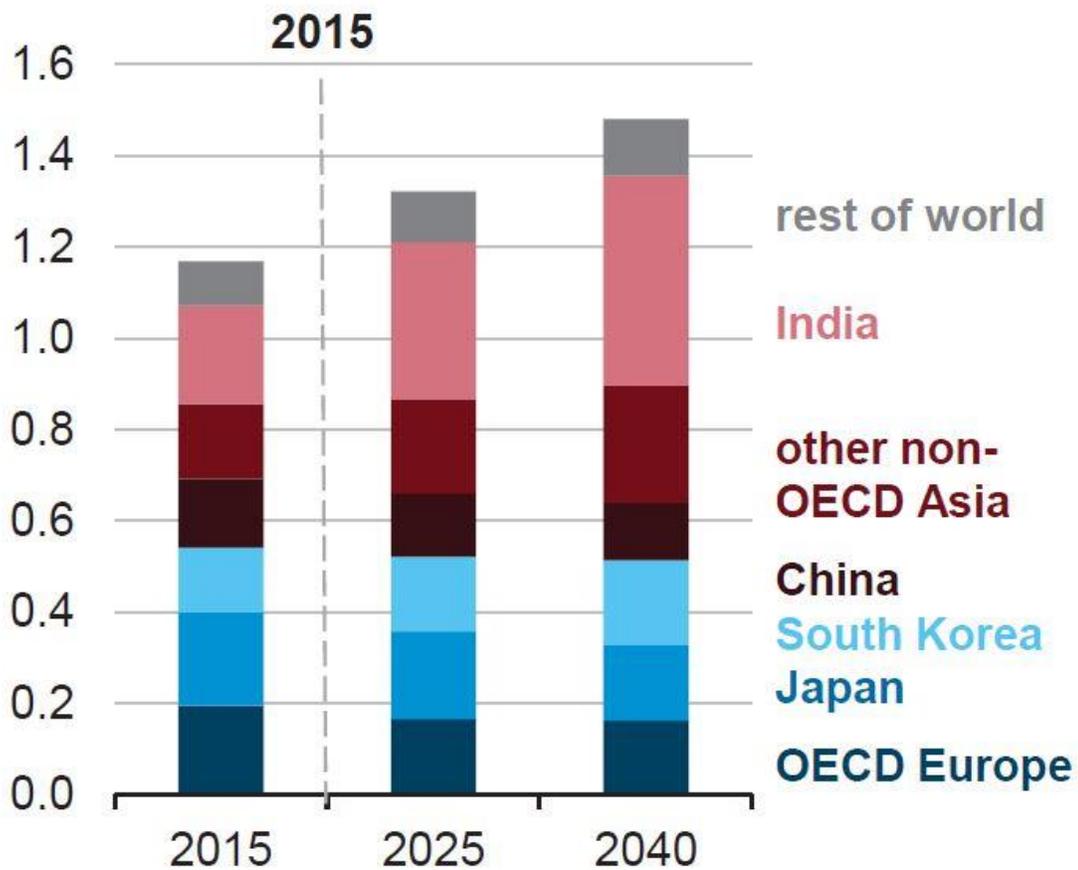


Figure 3. World coal imports projected to 2040. Values are in billion short tons (Bst). From Energy Information Administration (2017a).

## Coal exports billion short tons

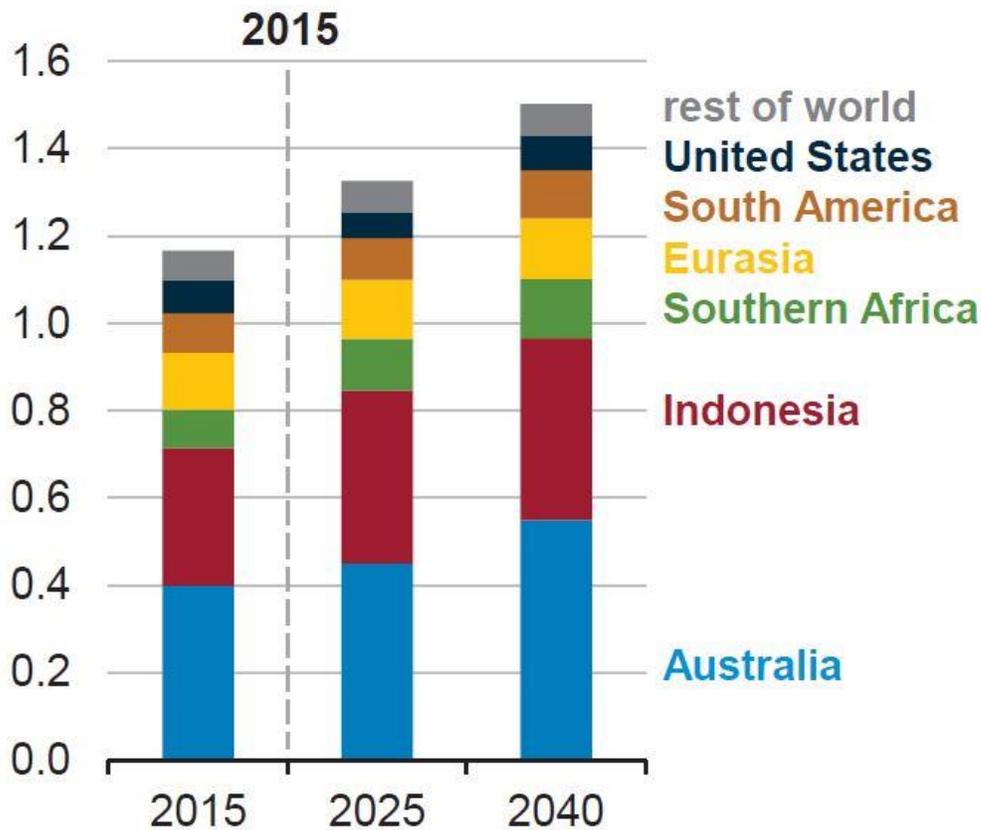


Figure 4. World coal exports projected to 2040. Values are in billion short tons (Bst). From Energy Information Administration (2017a).

### China

China continues to lead the world in coal production, with 2016 production at 3,574.2 MMst (3,242.5 MMt) (Table 1). Of the 28 provinces in China that produce coal, Shanxi, Inner Mongolia, Shaanxi, and Xinjiang contain most of China's coal resources (Meng et al., 2009). China continued to be the largest energy consumer globally, representing 23% of the world's energy consumption. More than 90% of coal produced by China is from underground mines (Meng et al., 2009). Shenhua Group and China National Coal Group,

China's largest state-owned coal companies, produce ~50% of the coal in China. Local state-owned companies account for ~20%, with small mines producing 30%. Because of new government regulations and decreasing prices, many of the ~10,000 inefficient and small mines in the country are closing, with the result of large state-owned companies having a greater share in China's overall coal production. China is also welcoming foreign investment to modernize existing large-scale coal mines and to apply new technologies. In addition to coal, China is also becoming more open to foreign investment in CTL, coalbed methane (CBM), coal-to-gas (CTG), and slurry pipeline transportation projects.

Of the top-ten coal-producing countries in 2016, China accounted for ~45% of the world's coal production. However, China's coal production in 2016 declined 7.9% and coal consumption also fell by 1.6% in 2016. At the same time, natural gas production in China rose by 1.4% (British Petroleum, 2017a). However, coal is still China's main source of fuel, accounting for 62% of the nation's energy use.

A recent monthly decline in China's coal production in August, 2017 was linked to a landslide in Shanxi Province (Reuters, 2017a). August coal-production levels (320.8 MMst [291 MMt]) were the lowest since October, 2016. In addition, coke production for steel manufacture fell 5.3% in August to approximately 40.7 MMst (37 MMt).

Coal consumption in China is expected to fall from approximately 84 quadrillion Btu (British Thermal Units) in 2015 to approximately 73 quadrillion Btu (Fig. 5). Electric power and industrial use will continue to dominate China's coal consumption. Coal imports are also expected to decline (Fig. 6). China will import only about 3% of its coal for consumption through 2040 because of its policy to be self-sufficient (Energy Information Administration, 2017a).

Chinese companies are constructing or planning to develop more than 700 new coal-fired plants in China and around the world (Tabuchi, 2017). Approximately 20% of these new plants, to be located outside of China, would increase the world's coal-fired electricity output by >40%. Electricity generation in China is operated by state-owned holding

companies, although limited private and foreign investments have recently been made in the electricity sector. Improvements to power grids are also being made to deal with power shortages. China has expanded the construction of natural gas-fired and renewable power plants to introduce power to remote population centers. The relative contribution of coal for generation of electricity is projected to decline from 72 to 47% by 2040, with increasing contributions from other fuels (Fig. 7). Coal will continue to be important feedstock for electricity generation in China, reaching a high value of approximately 4,400 billion kilowatt-hours by 2030. Already 150 gigawatts (GW) of new coal-fired capacity has been canceled or delayed until at least 2020, in view of China's plans for stricter emission controls and retirements of old, inefficient power plants that account for up to 20 GW of power.

## Coal consumption in China quadrillion Btu

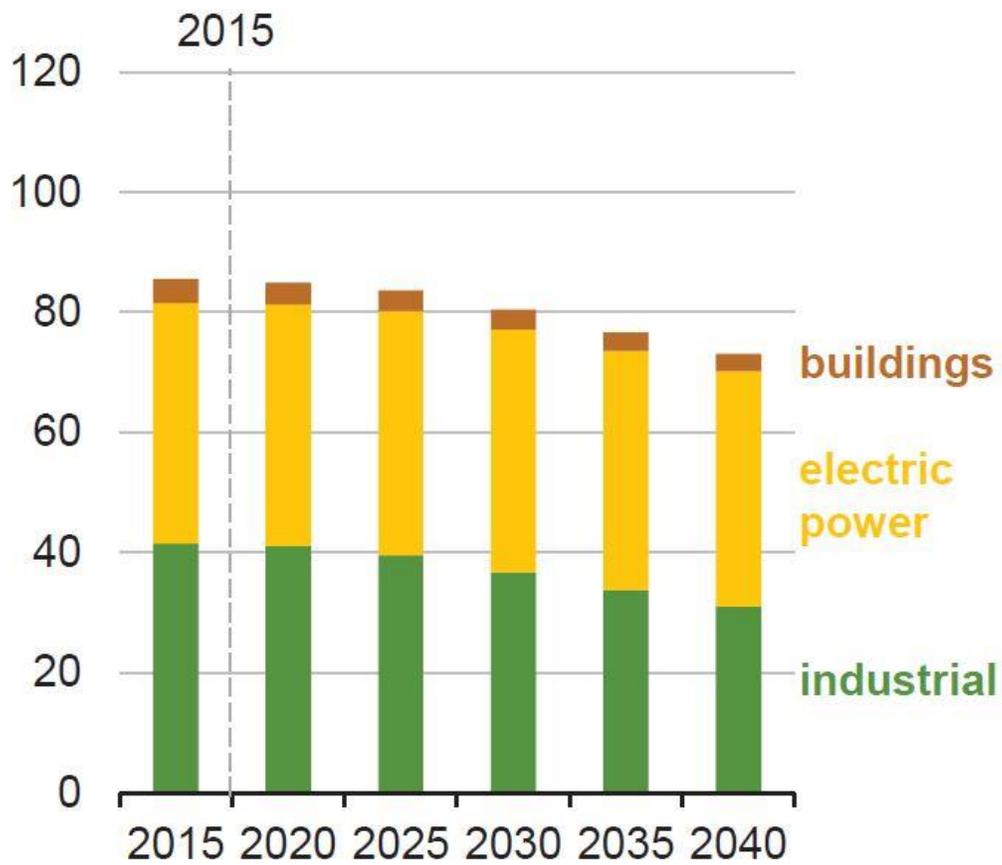


Figure 5. Coal consumption in China to 2040. Values are in quadrillion Btu (British Thermal Units). From Energy Information Administration (2017a).

## Coal imports in China

million short tons

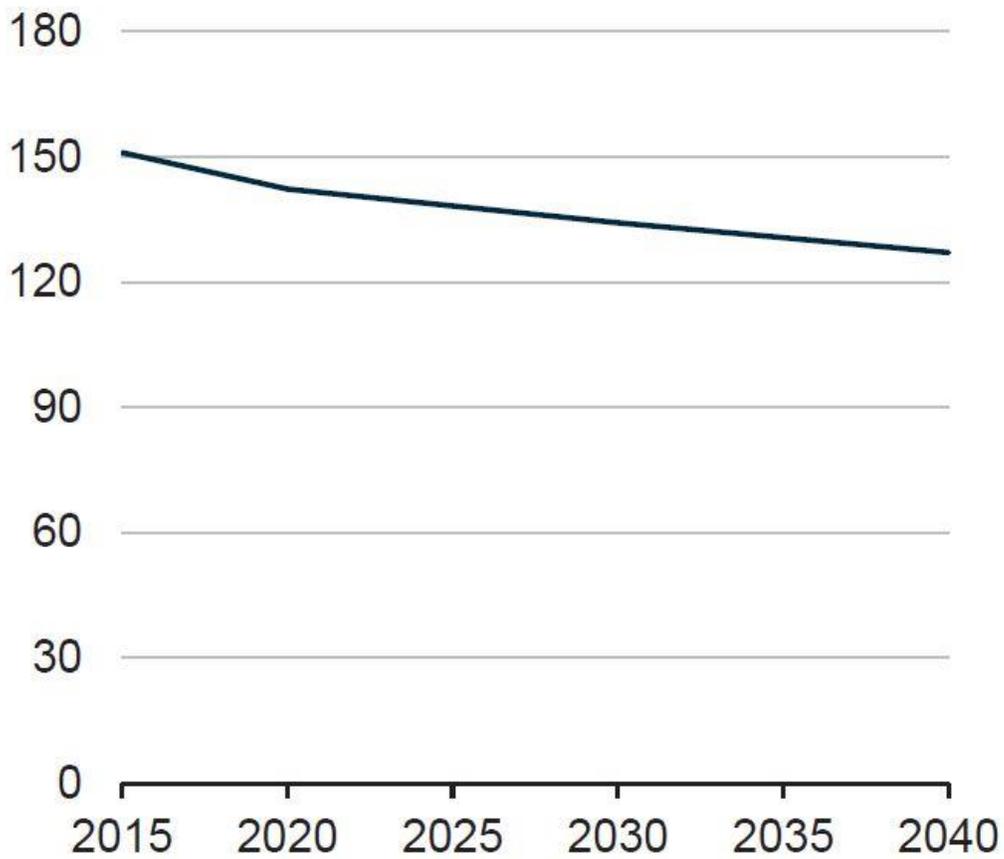


Figure 6. Coal imports to China to 2040. Values are in million short tons (MMst). From Energy Information Administration (2017a).

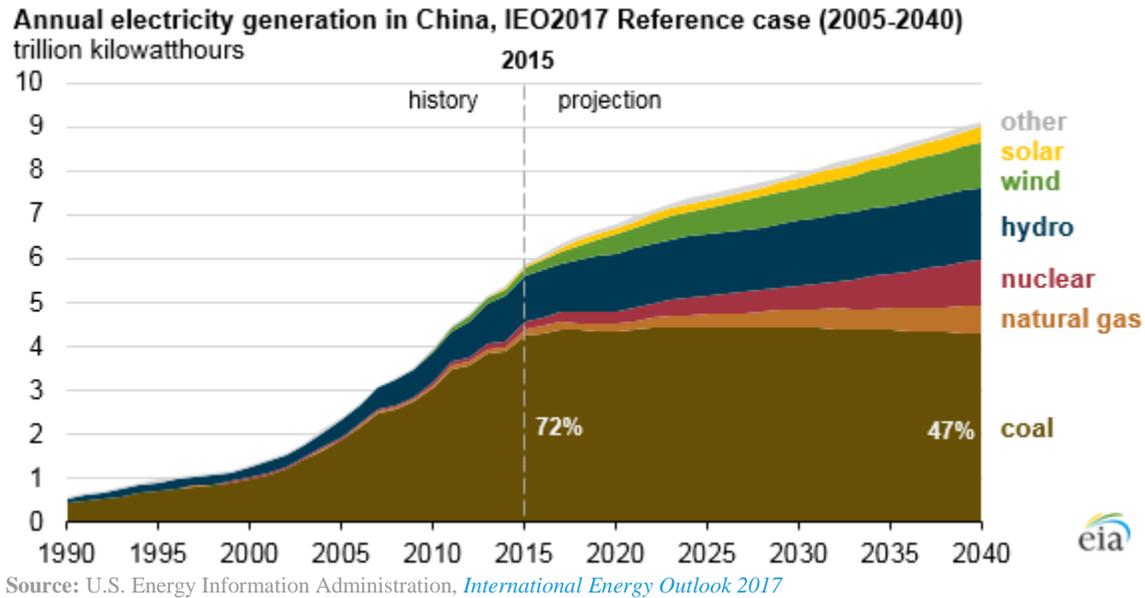


Figure 7. Annual electricity generation in China in 2015, projected to 2040. The relative contribution from coal is expected to fall from 72% to 47% by 2040. Values are in trillion kilowatt-hours. From Energy Information Administration (2017b).

## India

Most of India's coal reserves occur in the eastern part of the country. Jharkhand, Chhattisgarh, and Odisha states together comprise 64% of the country's coal reserves. Other significant coal-producing states include West Bengal, Andhra Pradesh, Madhya Pradesh, and Maharashtra (Energy Information Administration, 2016a). Coal India Limited (CIL) is India's largest and the world's largest coal producer, having produced >80% of the country's coal in the last five years (Reuters, 2016).

India's primary energy consumption increased by 5.4% in 2016, remaining the third-largest consumer of world energy (British Petroleum, 2017b). Coal is India's primary source of energy. India ranks second in coal production in the world (Table 1). Coal production in India grew by 2.4% in 2016 and India's share of world coal consumption is 11% (British Petroleum, 2017b).

Most of India's coal consumption is from electric power (Fig. 8). Coal demand in India is expected to increase significantly by 90% to 2040 because of industrial growth and continued rural electrification (Energy Information Administration, 2017a). Coal is expected to keep pace with other sources of energy for electricity generation (Fig. 9). Coal India Ltd. has been in contact with private power utilities, requesting that they consume more domestic coal. However, some power companies who operate plants in coastal areas in southern India favor imported coal, which for them is more economical where land-haulage is not involved.

Even though coal is the greatest provider of electricity generation in India, accounting for approximately 60% of installed power capacity, coal shortages continue to cause shortfalls in electricity generation, resulting in frequent blackouts. Approximately 90% of the country's coal mines are opencast mines, which although being cost-effective, cause environmental damage. India lacks advanced technology for large-scale, underground mining operations with the result that overall productivity levels in the country are low. Low levels of competition in the coal sector inhibit private and foreign investment and state regulations continue to cause delays for mining companies in receiving mining permits. Additional delays are caused by limited railway capacity, delays in new railroad projects, and high transport costs. However, India has recently completed three major rail transportation projects for increased shipments of coal from major producing regions in northeastern India to other parts of the country.

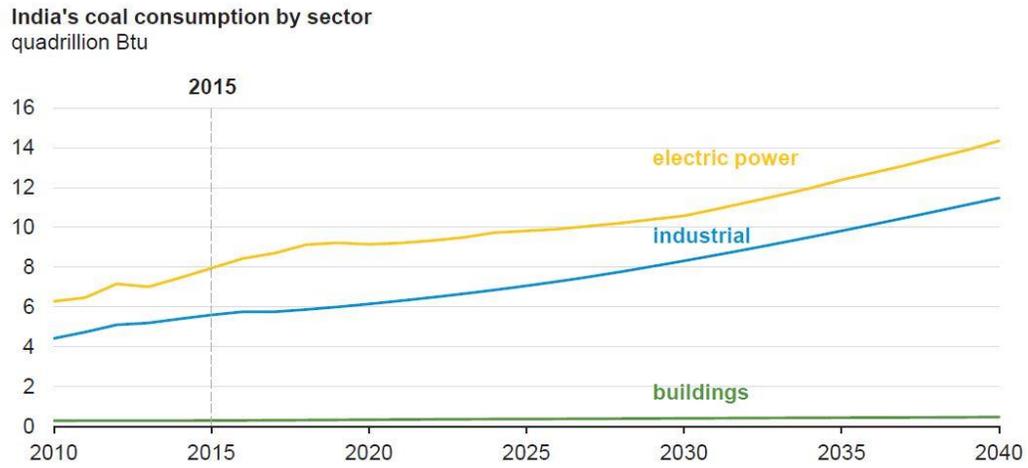


Figure 8. India's coal consumption by sector, projected to 2040. Values are in quadrillion Btu (British Thermal Units). From Energy Information Administration (2017a).

# Sources of electricity generation in India

billion kilowatthours

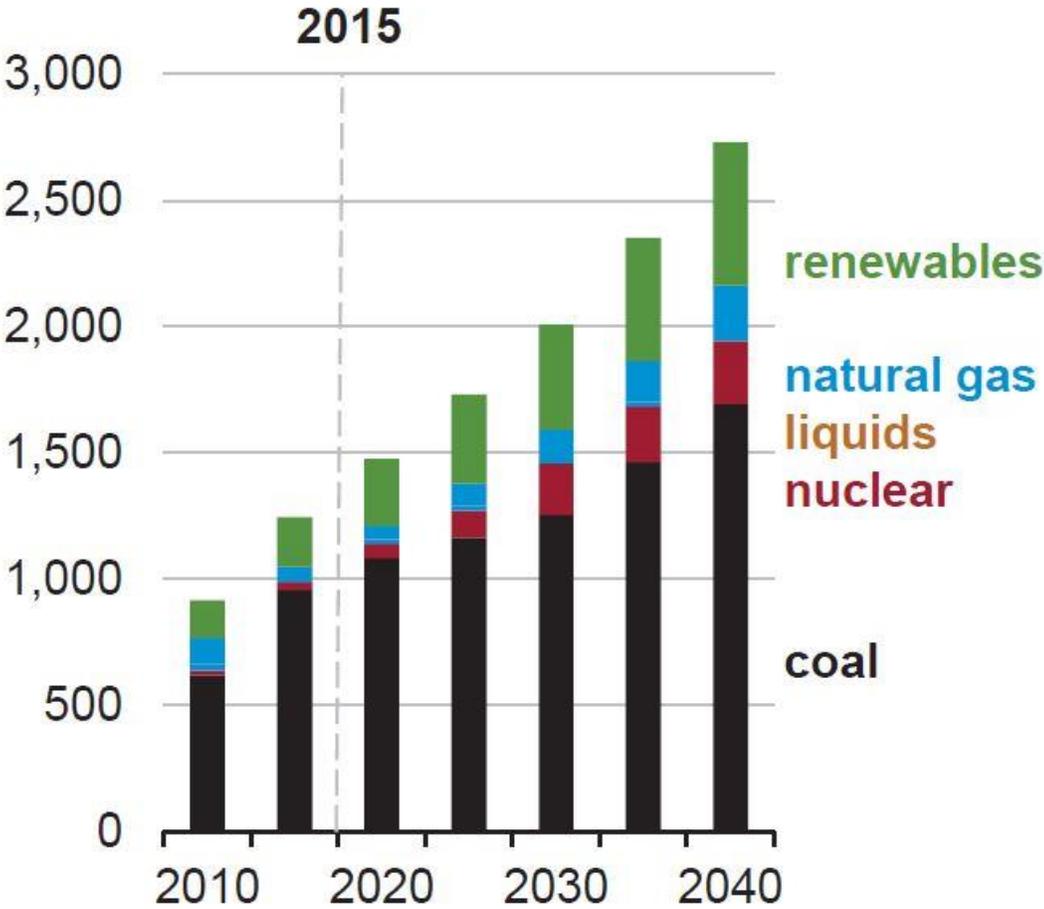


Figure 9. Projected sources of electricity generation in India to the year 2040. Values are in billion kilowatt-hours. From Energy Information Administration (2017a).

## United States

### Future Trends, Production, and Exports

Natural gas continues to take a larger share of the U.S. energy base relative to coal. By 2020, natural gas will overtake coal as the dominant fuel (British Petroleum, 2017c). According to the April-June 2017 Quarterly Coal Report (Energy Information Administration, 2017c), released in October, 2017, U.S. coal production from January to June was 384,115 thousand short tons (~384 MMst) [~348 MMt], representing a 15% increase relative to a comparable period in 2016 (Table 2). However, January to June, 2017 production was less than that of the third and fourth quarters in 2016. Production of steam coal, dedicated to electric power generation, continues to far exceed production of metallurgical coal in the United States (Fig. 10).

Wyoming continues to be the leading coal-producing state, having produced 152,535 Mst (152.5 MMst [138.3 MMt]) in the first half of 2017, a 21.9% increase relative to a comparable period in 2016 (Table 3). States experiencing sharp declines in coal production include Ohio (-35%) and Tennessee (-21.9%). The Powder River Basin was maintained as the number-one major supply region for the U.S., with first-half 2017 coal production of almost 160,000 Mst ([160 MMst [145.1 MMt]) (Table 3 and Fig. 11). Monthly exports of coal and coke in the first half of 2017 have remained either steady or have slightly increased (Figs. 12 and 13, respectively).

### Coal Data Sources

The Energy Information Administration has an interactive, online Coal Data Browser that provides detailed information on U.S. coal. Accessible at <http://www.eia.gov/beta/coal/data/browser/>, this data site integrates comprehensive information, statistics, and visualizations for U.S. coal, including electricity generation.

The browser also allows users to access data from the Mine Safety and Health Administration and coal trade information from the U.S. Census Bureau.

The Coal Data Browser allows the user to:

- Map coal imports and exports by country and by U.S. ports handling coal.
- Map where mines send coal and where power plants obtain coal.
- Analyze coal receipts by sulfur, ash, and heat content, as well as per mine.
- Observe changes in coal prices.
- Cross-link mine-level data pages with EIA's [U.S. Energy Mapping System](#) to discover data on all active coal mines.
- Observe changes in coal-worker employment in specific states.

The Energy Information Administration also provides an energy mapping system for a variety of energy sources that include coal, including coal mines and location and identity of coal-fired electricity installations in the United States. Information on coal can be accessed at: <https://www.eia.gov/state/maps.cfm?v=Coal>. The general site can be reached via: <https://www.eia.gov/state/maps.cfm?v=Fossil%20Fuel%20Resources>.

The annual coal distribution report for 2016, released on November 21, 2017 by the Energy Information Administration (2017h), consists of an archive of coal distribution by state, destination by state, consumer category, method of transportation, as well as foreign coal distribution by major coal-exporting state. It can be accessed at <https://www.eia.gov/coal/distribution/annual/archive.php>.

In addition, the annual coal report, released on November 15, 2017 by the Energy Information Administration (2017i), provides annual data on U.S. coal production, number of mines, productive capacity, recoverable reserves, employment, productivity, consumption, stocks, and prices. Highlights for the year 2016 include a decline of the productive capacity of U.S. coal mines by 8.6% from the years 2015 to 2016, with a concomitant decline in coal consumption by 8.4%.

Year and Quarter	Production <sup>1</sup>	Imports	Waste Coal Supplied	Producer and Distributor Stocks <sup>2</sup>	Consumption	Exports	Consumer Stocks <sup>2</sup>	Losses and Unaccounted For <sup>3</sup>
<b>2011</b>								
January - March	273,478	3,381	3,354	48,165	254,647	26,617	172,581	-
April - June	264,291	3,419	3,069	50,507	241,247	26,987	171,795	-
July - September	275,006	3,588	3,500	49,909	279,722	25,976	150,881	-
October - December	282,853	2,700	3,287	51,897	227,332	27,679	180,054	-
<b>Total</b>	<b>1,095,628</b>	<b>13,088</b>	<b>13,209</b>		<b>1,002,948</b>	<b>107,259</b>		<b>11,506</b>
<b>2012</b>								
January - March	266,865	2,022	2,893	51,141	207,833	28,642	202,166	-
April - June	241,047	2,329	2,500	50,374	201,555	37,534	205,023	-
July - September	258,956	2,415	2,982	46,231	253,984	31,563	189,530	-
October - December	249,591	2,394	2,821	46,157	225,813	28,006	192,696	-
<b>Total</b>	<b>1,016,458</b>	<b>9,159</b>	<b>11,196</b>		<b>889,185</b>	<b>125,746</b>		<b>14,980</b>
<b>2013</b>								
January - March	244,867	1,429	3,169	48,422	228,987	31,835	178,419	-
April - June	243,211	2,756	2,687	50,129	216,014	29,427	178,110	-
July - September	257,595	2,398	2,782	47,135	253,357	28,589	160,079	-
October - December	239,169	2,323	2,640	45,652	226,084	27,809	154,676	-
<b>Total</b>	<b>984,842</b>	<b>8,906</b>	<b>11,279</b>		<b>924,442</b>	<b>117,659</b>		<b>1,451</b>
<b>2014</b>								
January - March	245,271	2,450	3,277	44,728	248,329	27,584	123,990	-
April - June	245,844	3,574	2,896	42,682	211,881	24,674	139,471	-
July - September	255,377	3,151	3,256	38,828	247,453	22,723	131,386	-
October - December	253,557	2,174	2,662	38,894	210,068	22,276	158,833	-
<b>Total</b>	<b>1,000,049</b>	<b>11,350</b>	<b>12,090</b>		<b>917,731</b>	<b>97,257</b>		<b>11,101</b>
<b>2015</b>								
January - March	240,324	3,009	2,821	39,610	212,772	21,979	160,509	-
April - June	212,557	2,640	2,209	39,399	188,975	19,766	173,314	-
July - September	236,823	2,965	2,722	36,213	229,393	16,914	169,784	-
October - December	207,237	2,705	2,217	35,871	166,974	15,299	202,560	-
<b>Total</b>	<b>896,941</b>	<b>11,318</b>	<b>9,969</b>		<b>798,115</b>	<b>73,958</b>		<b>5,452</b>
<b>2016</b>								
January - March	173,225	2,698	2,478	37,304*	165,984	14,153	198,466	-
April - June	160,853	2,292	1,898	37,127*	160,013	14,223	189,222	-
July - September	195,101	2,733	2,397	33,574*	223,108	12,552	163,988	-
October - December	199,186	2,127	1,953	33,699*	180,696	19,343	169,616	-
<b>Total</b>	<b>728,364</b>	<b>9,850</b>	<b>8,727</b>		<b>729,801</b>	<b>60,271</b>		<b>-8,015</b>
<b>2017</b>								
January - March	197,033	1,915	2,402	34,719*	173,598	22,307	168,856	-
April - June	187,082	2,197	1,743	34,240*	167,235	21,796	165,785	-
<b>Total</b>	<b>384,115</b>	<b>4,112</b>	<b>4,145</b>		<b>340,833</b>	<b>44,103</b>		<b>10,725</b>
2016 January - June	334,078	4,989	4,376		325,997	28,376		-
2015 January - June	452,880	5,649	5,030		401,748	41,745		-

1 Includes refuse recovery.

2 Reported as of the last day of the quarter.

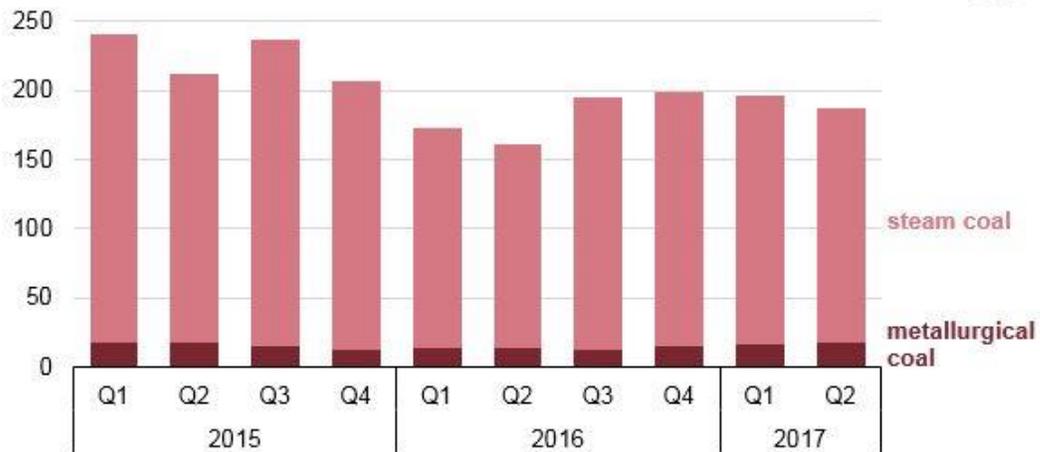
3 'Losses and Unaccounted For' is calculated as production plus imports plus waste coal supplied minus the change in producer and distributor stocks minus consumption minus exports minus the change in consumer stocks.

\* Estimated.

Table 2. U.S. coal summary statistics from 2011 to the first half of 2017. Values are thousands of short tons (Mst). Modified from Energy Information Administration (2017c).

### Quarterly U.S. coal production (2015-2017)

million short tons



Source: U.S. Energy Information Administration, *Quarterly Coal Report*

Figure 10. Quarterly U.S. coal production from 2015 to the first half of 2017. Values are in million short tons (MMst). From Energy Information Administration (2017d).

Coal-Producing Region and State	April - June 2017	January - March 2017	April - June 2016	Year to Date		Percent Change
				2017	2016	
Alabama	3,476	3,273	2,322	6,749	4,770	41.5
Alaska	199	259	228	458	538	-14.8
Arizona	1,383	1,667	1,235	3,050	2,569	18.7
Arkansas	17	10	15	27	27	-0.3
Colorado	4,371	3,784	3,081	8,155	5,591	45.8
Illinois	12,771	12,617	11,062	25,388	22,289	13.9
Indiana	7,627	8,386	6,963	16,013	14,187	12.9
Kansas	-	-	-	-	27	-
<b>Kentucky Total</b>	<b>11,369</b>	<b>11,422</b>	<b>9,971</b>	<b>22,791</b>	<b>21,414</b>	<b>6.4</b>
Eastern (Kentucky)	5,363	4,662	3,969	10,025	8,563	17.1
Western (Kentucky)	6,007	6,760	6,002	12,766	12,851	-0.7
Louisiana	470	955	696	1,425	1,352	5.4
Maryland	500	380	293	880	693	26.9
Mississippi	828	740	582	1,568	1,352	16.0
Missouri	62	59	68	122	110	10.8
Montana	7,800	7,243	6,210	15,043	13,639	10.3
New Mexico	3,514	3,744	2,460	7,257	6,755	7.4
North Dakota	6,584	7,234	6,462	13,818	13,672	1.1
Ohio	2,364	2,269	3,215	4,632	7,126	-35.0
Oklahoma	163	121	166	284	333	-14.6
<b>Pennsylvania Total</b>	<b>12,637</b>	<b>12,575</b>	<b>11,248</b>	<b>25,213</b>	<b>21,592</b>	<b>16.8</b>
Anthracite (Pennsylvania)	455	502	421	957	859	11.5
Bituminous (Pennsylvania)	12,182	12,074	10,828	24,256	20,734	17.0
Tennessee	119	152	142	271	347	-21.9
Texas	8,408	8,737	8,818	17,144	18,735	-8.5
Utah	3,403	3,523	3,706	6,927	7,068	-2.0
Virginia	3,359	3,575	3,184	6,934	6,317	9.8
<b>West Virginia Total</b>	<b>23,280</b>	<b>23,684</b>	<b>18,811</b>	<b>46,964</b>	<b>38,043</b>	<b>23.4</b>
Northern (West Virginia)	11,355	12,667	9,959	24,021	20,256	18.6
Southern (West Virginia)	11,925	11,018	8,852	22,943	17,787	29.0
Wyoming	72,161	80,374	59,663	152,535	125,170	21.9
<b>Appalachia Total</b>	<b>51,097</b>	<b>50,570</b>	<b>43,184</b>	<b>101,668</b>	<b>87,452</b>	<b>16.3</b>
Appalachia Central	20,766	19,407	16,148	40,173	33,014	21.7
Appalachia Northern	26,856	27,891	24,715	54,746	49,668	10.2
Appalachia Southern	3,476	3,273	2,322	6,749	4,770	41.5
<b>Interior Region Total</b>	<b>36,351</b>	<b>38,386</b>	<b>34,372</b>	<b>74,737</b>	<b>71,261</b>	<b>4.9</b>
Illinois Basin	26,404	27,763	24,027	54,167	49,326	9.8
Interior	9,947	10,623	10,345	20,571	21,935	-6.2
<b>Western Region Total</b>	<b>99,415</b>	<b>107,828</b>	<b>83,044</b>	<b>207,243</b>	<b>175,001</b>	<b>18.4</b>
Powder River Basin	75,863	83,926	62,360	159,789	131,532	21.5
Uinta Region	7,443	6,990	6,385	14,433	11,978	20.5
Western	16,109	16,912	14,300	33,020	31,490	4.9
East of Mississippi River	78,330	79,073	67,793	157,403	138,130	14.0
West of Mississippi River	108,534	117,711	92,808	226,245	195,583	15.7
<b>U.S. Subtotal</b>	<b>186,864</b>	<b>196,784</b>	<b>160,601</b>	<b>383,648</b>	<b>333,713</b>	<b>15.0</b>
Refuse Recovery	218	249	252	467	364	28.2
<b>U.S. Total</b>	<b>187,082</b>	<b>197,033</b>	<b>160,853</b>	<b>384,115</b>	<b>334,078</b>	<b>15.0</b>

Note: Total may not equal sum of components because of independent rounding.

Source: U.S. Department of Labor, Mine Safety and Health Administration, Form 7000-2, "Quarterly Mine Employment and Coal Production Report."

Table 3. U.S. coal production by state, 2016 to June 2017. Values are thousands of short tons (Mst). Modified from Energy Information Administration (2017c).



Figure 11. Quarterly U.S. coal production from by major supply region from 2015 from the first half of 2017. Values are in million short tons (MMst). From Energy Information Administration (2017d).

### Monthly coal exports

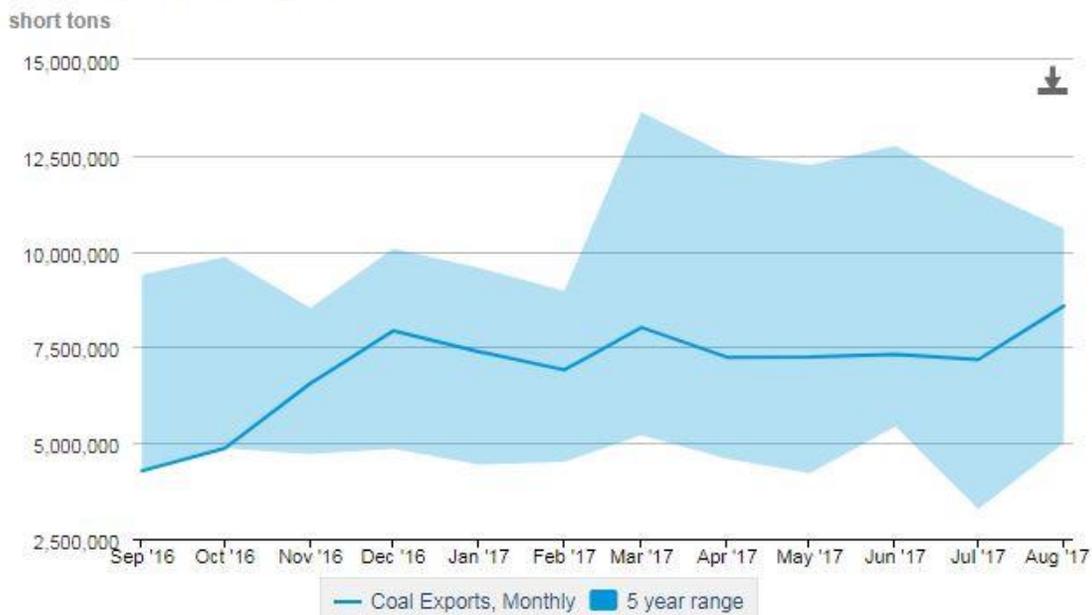


Figure 12. Monthly U.S. coal exports from September 2016 to August 2017. Values are in short tons (st). From Energy Information Administration (2017d).

## Monthly coke exports



 Source: U.S. Department of Commerce, Bureau of the Census

Figure 13. Monthly U.S. coke exports from September 2016 to August 2017. Values are in short tons (st). From Energy Information Administration (2017d).

## Australia

Australia is the top-ranked coal-exporting nation. By 2040, Australia will provide 37% of the world's coal exports (Fig. 4). Metallurgical coal is Australia's second-largest export commodity, exceeded only by iron ore on a weight basis. Australia exported

approximately US \$28 billion of both metallurgical and steam coal in FY 2015 (Energy Information Administration, 2017e). Most of the Australia's coal, which is typically low in ash content, occurs in Queensland and New South Wales (Sydney and Bowen Basins, respectively). These basins accounted for most of Australia's black coal production in 2015. The Gippsland Basin in Victoria was associated with 96% of brown coal production in the same year.

Coal production in Australia has grown by 42% in the last ten years. Most of Australia's coal is exported, with domestic use being <25% of total production (Fig. 14). Coal accounts for 32% of all energy consumption (Fig. 15) and 63% of electric generation in Australia (Fig. 16). Coal consumption in Australia had been declining because of fuel switching to natural gas and increased reliance on renewables. However, after repeal of the carbon tax in 2014, coal consumption has increased slightly since 2015 (Energy Information Administration, 2017e). In addition, a resurgence in coal mining in Australia is related to the country eclipsing Indonesia as the top-ranked, coal-exporting nation, with markets in China, India, Japan, South Korea, and other countries in southeast Asia. Coal exports are supported by nine major coal ports and export terminals in Queensland and New South Wales. These terminals have a combined capacity of >510 MMst (>462.7 MMt) per year. New port projects are being developed and were projected to add >50 MMst (>45.4 MMt) to annual coal loading capacity into 2017 (Energy Information Administration, 2017f). Australia has ~120 privately-owned coal mines (Energy Information Administration (2017f). Most of Australia's coal production is from open pit operations. BHP Billiton, Anglo American (UK), Xstrata (Switzerland), and Rio Tinto (Australia-UK), are major players in Australia's coal industry. Australia has invested \$11.2 billion in advanced infrastructure projects to add nearly 80 MMst (72.6 MMt) to production capacity by 2017.

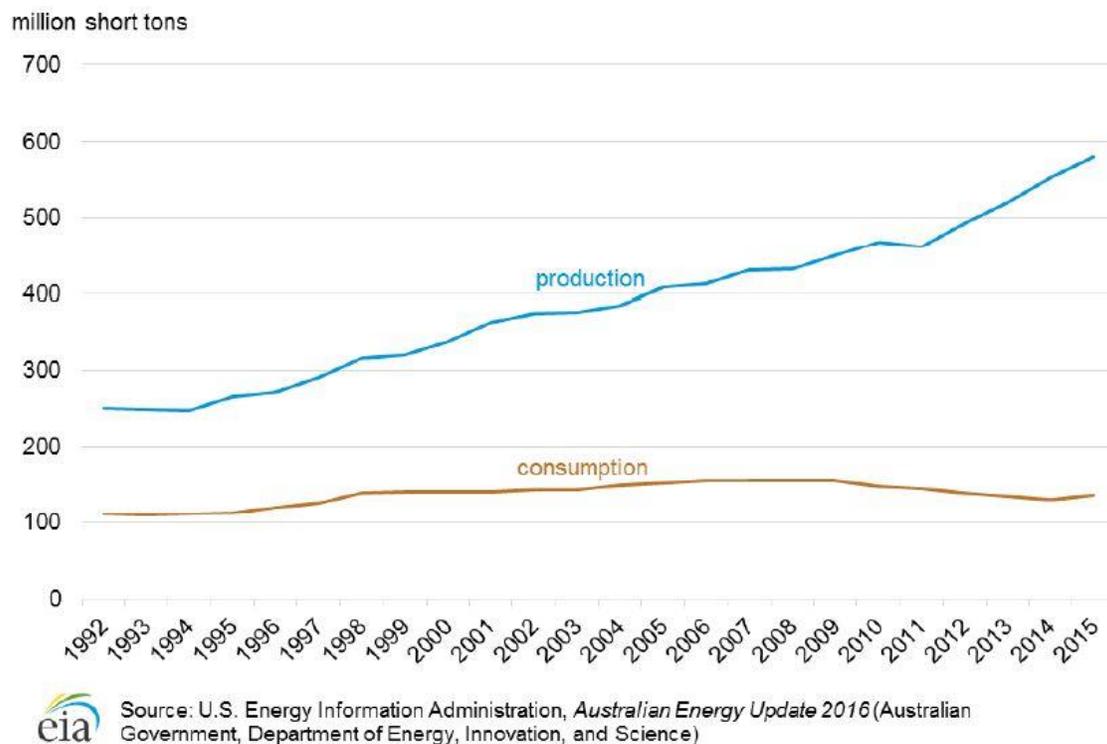
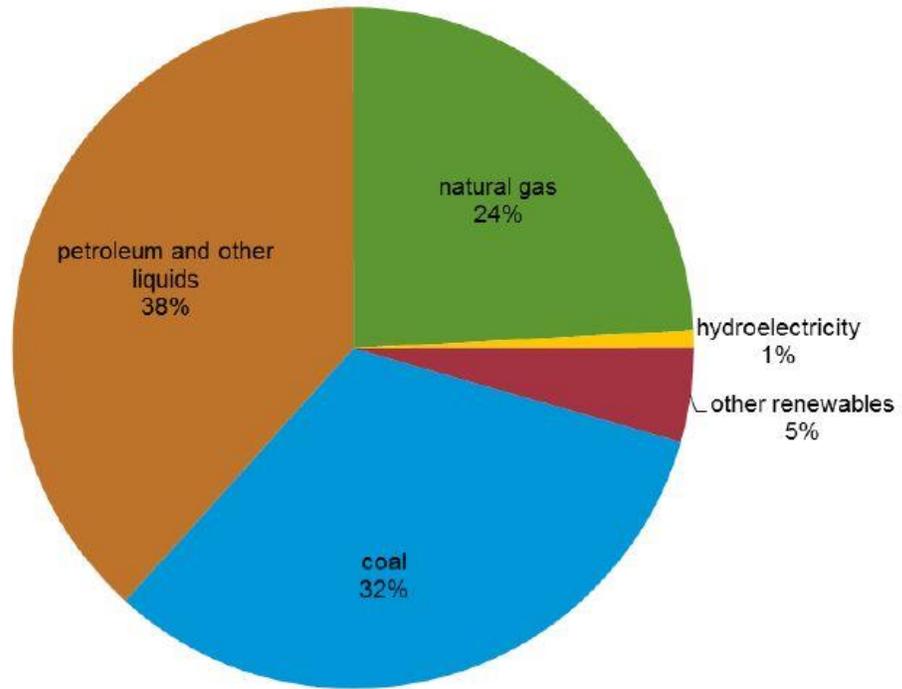


Figure 14. Coal production and consumption in Australia from 1992 to 2015. Values are in million short tons (MMst). Modified from Energy Information Administration (2017e).

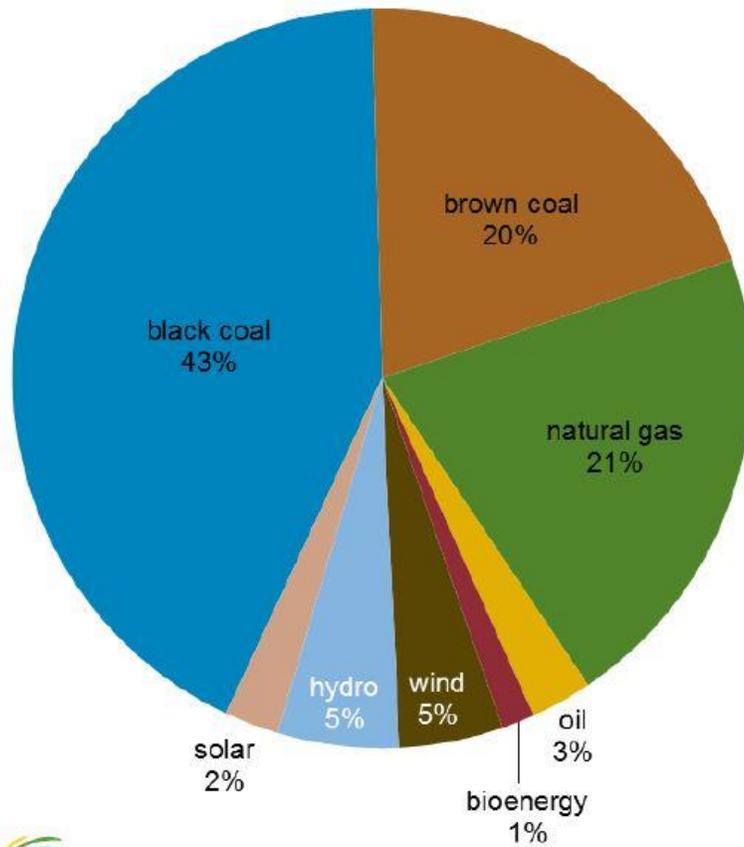


Note: Numbers may not add because of rounding.



Source: Australian Government, Department of Environment and Energy, *Australian Energy Update 2016*

Figure 15. Relative percentage of energy consumption in Australia in 2015 according to fuel type. Modified from Energy Information Administration (2017e).



Note: Fiscal Year 2015 is July 2014 to June 2015  
Source: Australian Department of Industry, Innovation, and Science

Figure 16. Relative percentage of energy sources for electricity generation in Australia in 2015 according to fuel type. Modified from Energy Information Administration (2017e).

## Indonesia

The three largest coal-resource regions in Indonesia are South Sumatra, South Kalimantan, and East Kalimantan (Fig. 17). Indonesia currently ranks ninth in coal reserves worldwide, containing slightly more than 2% of total global coal reserves (Indonesian-Investments, 2017). Approximately 60% of these reserves are composed of subbituminous coal.

Production, export, and consumption of coal in Indonesia have all increased substantially since 2007 (Table 4). Indonesia exports almost 80% of its produced coal (Energy Information Administration, 2015). Indonesia has recently become important as a source for Chinese coal imports. Indonesia's coal exports are primarily destined for Asian markets, with 85% of total coal exports going to China, Japan, South Korea, India, and Taiwan.

Indonesia's energy mix, projected to the year 2025, includes increased reliance on coal, although renewable energy is expected to rise at a higher rate than that for coal (Table 5). Indonesia is projected to increase annual coal production by an average of 3% to 2020 (Jardine Lloyd Thompson Group, 2017). One of the main reasons for this projected increase is because the Government of Indonesia plans to invest in power infrastructure in the near future, hoping to reach a level of 99.7% electrification by 2025. This plan calls for coal to compose 60% of the overall national fuel mix to achieve a total power capacity of 90.5 GW by the end of 2019.

PT Bumi Resources Tbk is Indonesia's largest mining company and coal producer, with 88 MMst (79.8 MMt) produced in 2013. PT Bumi plans have been to increase production of power-station coal in 2017, in expectation of stable coal prices that reflect recent rises in Chinese thermal coal futures (Jensen, 2016). PT Adaro is the second-largest coal producer in Indonesia, accounting for almost 60 MMst (54.4 MMt) of coal in 2013. Other major producers include PT Kideco Jaya, PT Indotambang Raya Megah, and PT Berau. The top five producers in Indonesia have recently accounted for more than 45% of coal production (Indonesian-Investments, 2017).



Figure 17. The three major coal-resource regions in Indonesia. Regions are (1) South Sumatra, (2) South Kalimantan, and (3) East Kalimantan. From Indonesia-Investments (2017).

**Indonesian Production, Export, Consumption & Price of Coal:**

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
<b>Production</b> (in mln tons)	217	240	254	275	353	412	474	458	461	419
<b>Export</b> (in mln tons)	163	191	198	210	287	345	402	382	366	333
<b>Domestic</b> (in mln tons)	61	49	56	65	66	67	72	76	87	86
<b>Price (HBA)</b> (in USD/ton)	n.a	n.a	70.7	91.7	118.4	95.5	82.9	72.6	60.1	61.8

Sources: Indonesian Coal Mining Association (APBI) & Ministry of Energy and Mineral Resources

Table 4. Production, export, consumption, and coal prices in Indonesia from 2007 to 2016. From Indonesia-Investments (2017).

### Indonesia's Energy Mix:

	Energy Mix 2011	Energy Mix 2025
Oil	50%	23%
Coal	24%	30%
Gas	20%	20%
Renewable Energy	6%	26%

Source: Ministry of Energy and Mineral Resources

Table 5. Projected energy mix in Indonesia projected to the year 2025. From Indonesia-Investments (2017).

## Russia

Approximately 80% of Russia's coal production is thermal (steam) coal and, and 20% is metallurgical (coking) coal. Russia's coal reserves account for almost 18% of the world's total coal reserves, although Russia's share of coal production has recently been <5% (Fig. 18) (Sliviyak, 2015). More than half of Russia's coal exports, which have risen significantly since 2002, go to Europe. China accounts for 16% of Asian exports, whereas the United Kingdom receives 10% (Fig. 18).

The majority of Russia's coal production and reserves are located in the Kansk-Achinskiy and Kuznetskiy Basins in central Russia (Fig. 19). Coal in these regions requires long-distance transport to reach markets, placing Russian coal at an economic disadvantage with respect to other competing sources. However, some economists believe that the weaker ruble, resulting from sanctions and low oil prices, should make Russian coal exports more price-competitive. Russia has plans to expand its port capacity for increased Asian exports.

Coal production in Russia has risen in the last three years, having increased by 3% by the end of 2017 and reaching a value of 438.4 MMst (397.7 MMt) (Reuters, 2017b). Thermal coal exports will exceed 168.7 MMst (153 MMt) in 2017, up from 164.2 MMst (149 MMt) in 2016. Metallurgical coal exports will have risen from 23.9 MMst (21.7 MMt) to between 25.4 and 26.5 MMst (23 and 24 MMt).

Russian thermal coal exports to Europe are expected to diminish in the next decades as Europe develops more green-energy systems, coupled with greater competition from exports from Colombia and the United State (IHS Markit, 2017). Russian export markets are anticipated to shift to southeast Asia, with Russia exporting 57.3 MMst (52 MMt) to southeast Asia and the Pacific Rim by 2020.

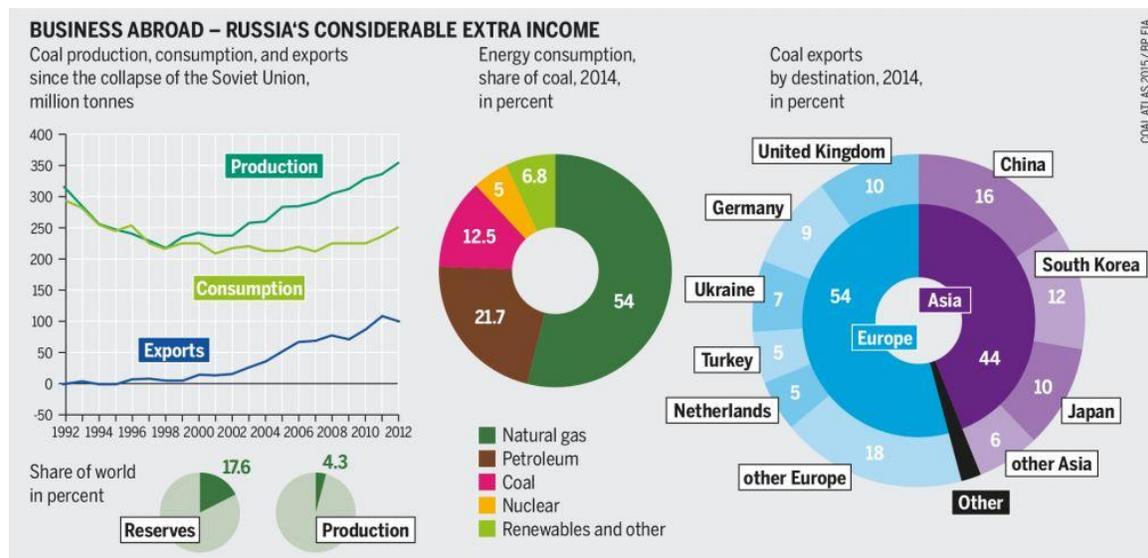


Figure 18. Summary of Russia's coal production, consumption, reserves, and exports. From Slivyak (2015).

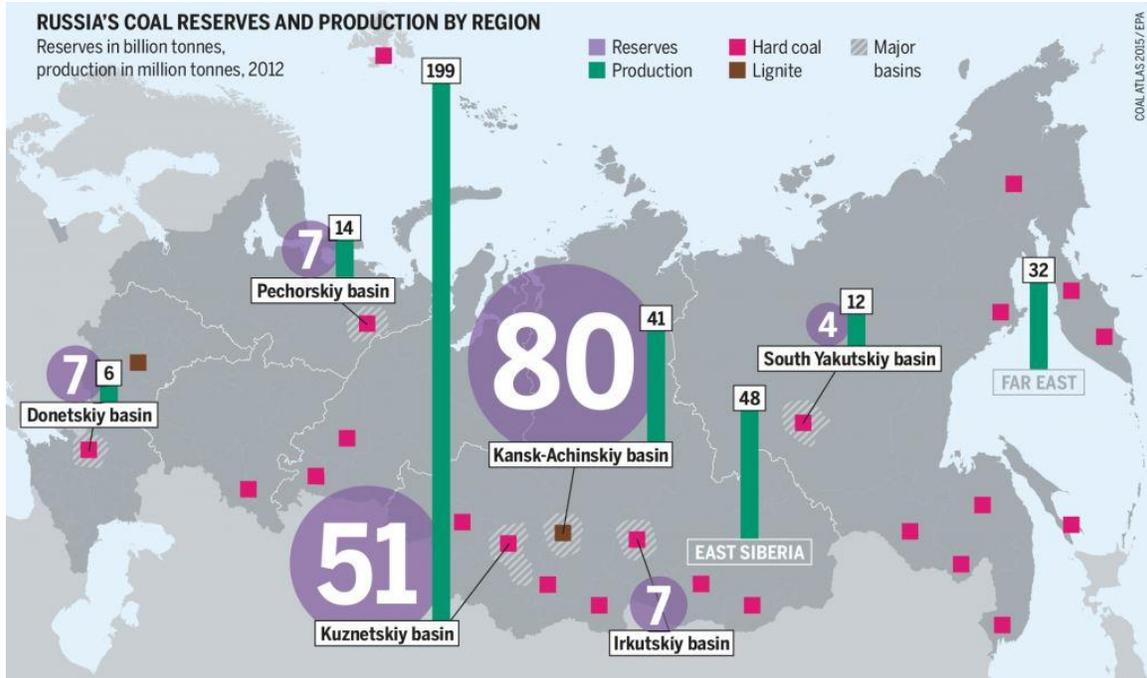


Figure 19. Russia's coal reserves and production by region. Reserves are in billion metric tons (Bt). Production is in million metric tons (MMt). From Sliviyak (2015).

## South Africa

South Africa contains 95% of Africa's total coal reserves (Energy Information Administration, 2016b), and relies heavily on its large-scale, coal mining industry. The country also has a well-developed synthetic fuels (synfuels) industry, manufacturing gasoline and diesel fuel from the Secunda CTL plant and Mossel Bay GTL plant. The synfuels industry represents nearly all of South Africa's oil, as its domestic production is small. More than 37 MMst (>33.6 MMt) of coal are processed yearly and converted into liquid fuels and a range of chemical feedstock at the Sasol synfuels plant in Secunda. The plant has a capacity of 160,000 barrels per day (bbl/d) of oil equivalent. Sasol has plans for expanding Secunda's capacity by 30,000 bbl/d.

Coal accounts for 72% of the country's total primary energy consumption (Fig. 20). The electricity sector accounts for >50% of the coal consumed in South Africa, with lesser amounts represented by petrochemical and metallurgical industries followed by domestic heating and cooking.

Most of South Africa's coal production is from the northeastern part of the country (Fig. 20). South Africa exports have recently accounted for approximately 25% of its coal production. However, development of global alternative energy sources has affected South African coal-export markets (Olalde, 2017). In addition, there has been a trend of an increasing number of smaller coal-mining companies in South Africa, formerly dominated by large companies such as Eskom. Six companies in 2007 accounted for 90% of South Africa's production, with eight mines producing more than 60% of the country's coal. The number of coal mines in 2007 was 93, but increased to 148 mines by 2016. However, total coal production rose by only 10% in the same period.

Despite shrinking coal-export markets, domestic coal mining in South Africa remains a vital part of the economy, having employed more than 77,500 people in 2016, representing 17% of the total employment in the South African mining sector (Chamber of Mines of South Africa, 2017). Total coal sales were approximately R 112 billion, with coal-export earnings averaging 12% of all merchandise exports.

# LOCATION AND GEOLOGY

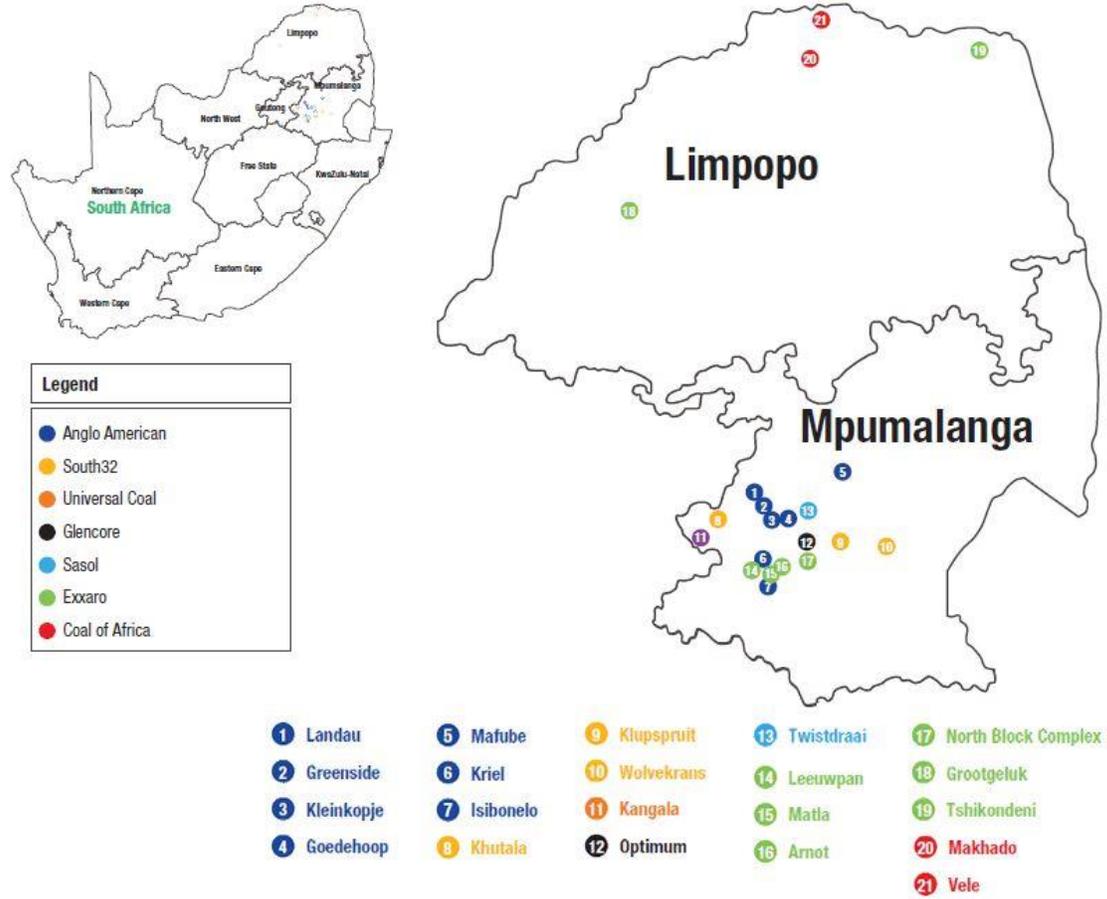


Figure 20. Principal coal mines and companies in South Africa. From Chamber of Mines of South Africa (2016).

## Germany

Coal is Germany's most abundant indigenous energy resource, and it accounted for about 25% of Germany's total primary energy consumption in 2014 (Energy Information Administration, 2016c). Power and industrial sectors consume most of the coal in Germany, with lignite-fired generation providing ~44% of total electric generation in 2014. Although Germany has large reserves of lignite and hard coal, only 22.0 MMst (~20 MMt) are planned for development because of Germany's decision to curtail subsidized hard coal production in 2018 (Euracoal, 2017a) and to reduce greenhouse gas emissions by 40% (from 1990 levels) by 2020 (Destatis, 2015). However, lignite's future in Germany is better, with an estimated 5,510 MMst (~5,000 MMt) of mineable reserves in existing and approved surface mines.

Hard coal and lignite accounted for approximately 13% and 12% of Germany's main energy production, respectively, in 2015 (Euracoal, 2017a). However, 90% of Germany's hard coal was imported, mainly from Russia, Colombia, the United States, Australia, Poland and South Africa. Lignite production in Germany in 2015 was 196.2 MMst (~178 MMt). This production came from four main areas that include (1) the Rhenish mining district encompassing Cologne, Aachen and Mönchengladbach, (2) the Lusatian mining district in southeastern Brandenburg and northeastern Saxony, (3) the Central German mining district in southeastern Saxony-Anhalt, and (4) and in northwestern Saxony as well as the Helmstedt mining area in Lower Saxony (Euracoal, 2017a). Almost 90% of the lignite was employed for power generation. Slightly more than 42% of electric power generation in Germany in 2015 came from hard coal and lignite. Coal-fired power plants in Germany are still required to compensate for nuclear power, which Germany is foregoing in the wake of the Fukushima incident. Germany's current energy mix reflects long-term plans to eventually phase out coal while renewable-energy sources are developed (Fig. 21).

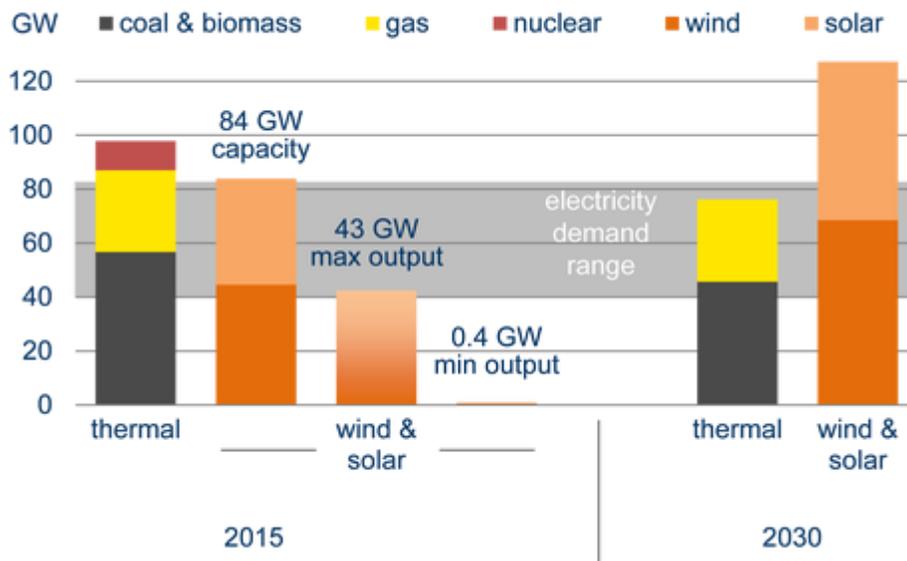


Figure 21. Germany’s projected energy mix from 2015 to 2030. Values are in gigawatts (GW). From Euracoal (2017a).

## Poland

Poland is the second largest coal producer in Europe, with Germany in first rank (Energy Information Administration, 2016d). Coal accounted for 55% of energy consumption, with oil representing 26%, natural gas being 15%, and renewable energy sources comprising 4%. Poland consumes virtually all its domestic coal production, with minor coal exports to the Czech Republic, Germany, and Ukraine (Platts, 2015). Poland’s coal-fired power plants represent >75% of installed electric generating capacity.

Compared with other countries in the European Union, Poland has large reserves of hard coal and lignite that are devoted to electricity generation (Euracoal, 2017b). Hard coal reserves in Poland amount to 23.3 billion short tons (Bst), or 21.1 Bt, most of which are

located in the Upper Silesian and Lublin coal basins. Lignite reserves in the country are 1.54 Bst (1.4 Bt). In addition, 24.4 Bst (22.1 Bt) of lignite resources exist in Poland.

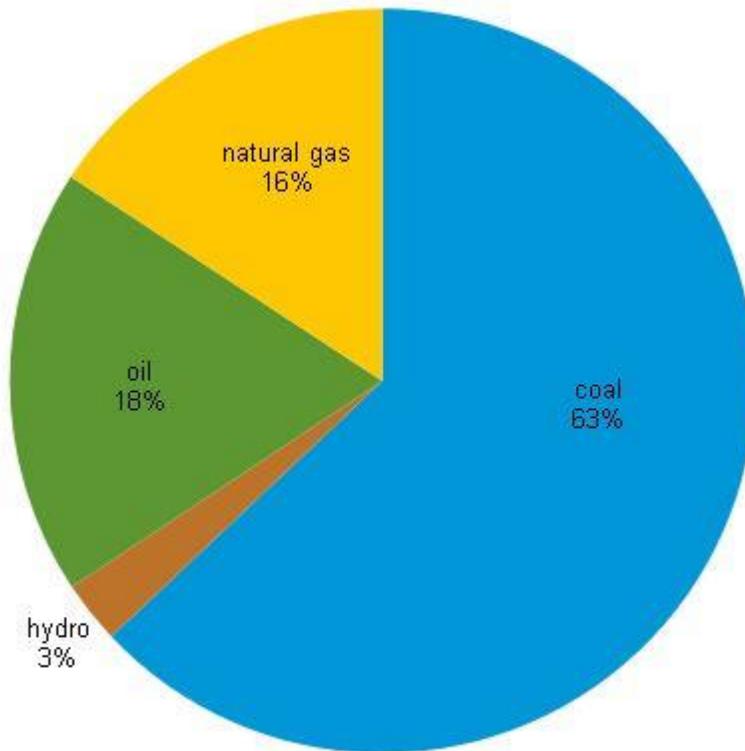
Upper Silesia accounts for ~approximately 79% of Poland's reserves of hard coal, with approximately half of these seams being economically workable. These hard coal reserves, almost all of which are mines with longwall systems, are mined at an average depth of ~1,970 ft (600 m). Steam coal represented 82% of hard coal mined in 2015 (Euracoal, 2017b).

Lignite reserves in Poland are mined at the surface. Two mines are in central Poland, whereas a third is in the southwestern part of the country. Production of lignite in 2015 was 69.6 MMst (63.1 MMt). Virtually of this lignite is devoted to mine-mouth power plants (Euracoal, 2017b). Approximately 80% of Poland's electrical generation capacity is from hard coal and lignite. Abundant coal in Poland is seen as a means of lessening dependence on Russian natural gas, with climate objectives as being secondary (Bauerova, 2015). Poland has the lowest reliance on natural gas among the EU's 10 largest economies. Polish industry spent 23% less for power than German industry in 2012, as well as having provided jobs for >100,000 people.

## **Kazakhstan**

Coal accounts for >60% of Kazakhstan's total energy consumption (Fig. 22) (Energy Information Administration, 2016e). Despite Kazakhstan being ranked among the top-ten coal-producing countries (Table 1), it contributes comparatively little to global coal volumes (<4%) (World Energy Council, 2017). Kazakhstan exports ~25% of its own coal production (virtually all steam coal), with most exports bound for Russia (Energy Information Administration, 2017g). Kazakhstan plans to offset export losses to Russia with new markets in Finland, Greece Italy, Kyrgyzstan, the United Kingdom, and China, despite recent reductions in coal production in China.

Kazakhstan contains >400 coal deposits. Approximately one-third are composed of lignite. Most coal production is sourced from the Karaganda Basin, a source of underground coking coal, and the Ekibastuz Basin that supplies coal for electric-power generation (World Energy Council, 2017). Kazakhstan also produces minor volumes of metallurgical coal for domestic consumption. Coal provides most of Kazakhstan's power generation, with most coal-fired plants being located in the north part of the country. Kazakhstan's total installed generating capacity is ~18 GW, of which 87% comes from fossil fuels.



Source: U.S. Energy Information Administration

Figure 22. Relative percentage of energy consumption by fuel type in Kazakhstan in 2013. From Energy Information Administration (2016e).

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