

Energy 101: Introduction to Coal

From the CSIS Energy & National Security Program

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Coal is a combustible fossil fuel that is the most abundant and second-most widely used fossil-based energy source in the world, accounting for 29 percent of total primary energy demand in 2012. Most coal globally (65 percent) and in the United States (90 percent) is [consumed](#) by the electric utility industry, with the remainder consumed by industrial users.

Coal is [classified](#) according to the amount of moisture and carbon it contains, which determines the heat energy it can produce. There are four types (“ranks”) of coal: anthracite, bituminous, subbituminous, and lignite. Anthracite has the highest carbon and lowest moisture content (and is therefore the most expensive) and lignite has the highest moisture and lowest carbon content. The vast majority of [coal mined in the United States](#) is bituminous and subbituminous (45 percent and 47 percent by tonnage, respectively). Globally, according to the International Energy Agency (IEA), [51 percent of global coal reserves are anthracite and bituminous coals](#), compared with 32 percent subbituminous and 18 percent lignite.

Coal End-users

Coal accounted for 46 percent of electricity generation globally and 39 percent of [U.S.](#) electricity generation in 2013 (down from nearly 50 percent in 2005, due mostly to lower natural gas prices). Coal plays a large role in power generation because of its abundance, high energy content, availability, and relatively low, stable price. The use of coal in the electricity sector varies considerably by region, both internationally and within the United States. On average, the United States generated 39 percent of its electricity from coal in

Quick Facts about Coal

- Coal is measured in metric tons and short tons. A short ton is 2,000 pounds. A metric ton is 2,205 pounds (1,000 kilograms).
- The majority of [proved coal reserves](#) are in Europe and Eurasia (35 percent), followed closely by Asia Pacific (31 percent) and North America (29 percent). Coal reserves in the Middle East, Africa, and Latin America are minimal.
- On a country basis, the United States has the largest coal reserves in the world, with enough coal to last at least 200 years at current levels of consumption.
- Over two-thirds of global coal production is in the Asia Pacific region. U.S. production in 2011 was 1,089 million short tons, about 14 percent of global coal production.
- China alone accounts for over half of global coal consumption.
- U.S. consumption in 2011 was 1,003 million short tons, about 13 percent of global coal consumption.

2013; some [regions](#), such as the Midwest, rely on coal to meet around two-thirds of electricity needs, while other regions, such as the Pacific Northwest, are less coal dependent, generating around a quarter of their electricity from coal. Internationally, [coal consumption varies](#) due to a variety of factors such as resource endowment, relative cost, and environmental considerations.

Some regions use significantly less coal for electricity generation than the United States. Coal supplies only about 30 percent of Europe’s power needs; at the other end of the spectrum, about 80 percent of China’s installed electric capacity is supplied by coal. Some countries, such as South Africa and Poland, get nearly all of their electricity from coal generation.

Coal Markets

Coal is a globally traded commodity that is commercially mined in over 50 countries. Mining is done through [two primary methods](#): underground and surface, largely dependent on the geology of the coal seam. The latter is used when coal seams are less than 200 feet below the surface. Recovery rates vary based on the method of mining, geology, technology, and price.

Coal prices vary dramatically depending on the quality of the mined coal, including its energy, water, and sulfur content, among other qualities. In the United States, Central Appalachia coal traded at a spot price of \$52.88 in April 2015, compared with \$11.55 for Power River Basin coal and \$39.82 for Uinta Basin coal; the price in Northwest Europe was approximately \$59. Prices also vary greatly due to the cost of transportation, which can account for up to 70 percent of the delivered price. In order to minimize price volatility and increase reliability, most coal sold in the United States for electricity generation is sold through long-term contracts. Spot purchases (a single shipment or multiple shipments for delivery within one year) can supplement long-term contracts, but the latter generally provide lower prices and more price stability.

While coal prices are an important determinant of coal demand, the relative price of coal compared with other fuels also matters. The [price differential between coal and natural gas](#) has driven fuel-switching in the United States in recent years. However, in most of the world, natural gas is more expensive than coal.

Globally, as a result of rising incomes and consequently rising demand for energy, coal consumption is projected to increase in the coming years to 9 billion tons per year by 2019—a growth of approximately 2.1 percent per year—according to the IEA. China will account for approximately 60 percent of overall global demand even taking into consideration its slowed consumption growth. Other growth will come from emerging economies in Asia, offsetting declining consumption in Europe and the United States.

While the [internationally traded](#) volume of coal is large (around 1,142 metric tons in 2011), most coal is used in the country where it was produced. Traded coal represents only about 15 percent of total consumed coal. The coal trade is split into two main regions: the Atlantic and Pacific basins. The Pacific basin accounts for the majority (approximately three-quarters) of internationally traded coal.

The United States is the world’s fourth-largest coal exporter, behind Indonesia, Australia, and Russia. The United States both imports and exports coal, although exports are far greater than imports. (Most [U.S. coal is produced](#) in Wyoming, followed by West Virginia and Kentucky.) Different countries export different types of coal; Colombia, for example, is a major producer of thermal coal (for electricity production), whereas Canada is a major producer of metallurgical/coking coal (used in steel production). Many countries, like the United States, mine both types.

Globally, the world’s top coal importers are China, Japan, South Korea, India, and Taiwan. [China](#) is the largest consumer of coal in the world, burning more coal than the rest of the world combined. China has recently pledged to peak its carbon emissions around 2030, which will require lessening its dependence on coal; however, China will continue to burn large volumes of coal for the foreseeable future.

Coal and Climate

Coal is a significant source of greenhouse gas emissions both globally (43 percent) and in the United States (28 percent). In addition to releasing carbon dioxide, burning coal also releases [other pollutants](#) into the atmosphere that can lead to environmental and health problems. Effective regulation and technological innovation have led to the [decline](#) of these other pollutants in recent years. In the United States, proposed rules putting limits on carbon emissions from new and existing power plants are expected to be finalized before the end of President Obama’s second term.

In response to the recognition of the role that burning coal plays in climate change, some environmental groups have called for stricter regulation on coal plant emissions and the implementation of so-called clean coal technologies. Clean coal technologies include both pre- and post-combustion technologies that reduce the environmental footprint of coal use. Examples of such technologies include [integrated coal combined cycle](#), which captures and separates carbon, along with other technologies such as [ultrasupercritical](#) pulverized coal and oxyfuel plants. Widespread deployment of these technologies would improve the efficiency of coal combustion and reduce emissions, although they also have drawbacks. For example, these technologies are expensive to install and difficult to maintain. Another option is [carbon capture and storage](#) (CCS) technology, but what to do with the captured carbon is still an issue. Moreover CCS is expensive, can only be deployed in certain geologic formations, and there is limited commercial experience with the technology in the electricity sector. Other groups have called for an end to coal use in the electricity sector altogether, replaced by either cleaner-burning natural gas, renewables, or reduced demand through greater end-use efficiency. It is worth noting that while fuel-switching is technologically possible in the utilities sector, in iron and steel manufacturing, the options for switching away from coal are extremely limited.

To date, policy to address greenhouse gas emissions from coal has been driven by the existing economic and political realities—namely that coal is cheaper than renewable alternatives and until recently, consistently cheaper than natural gas. Proposing a shift away from coal is particularly controversial within emerging economies and the developing world, where coal remains the cheapest energy source on an energy density basis. The issue was exemplified by a recent debate within the international community about how to balance the commitment to ending energy poverty and provide an affordable means of development with the commitment to combat climate change. The [World Bank](#) announced its [plan](#) to limit financing for coal-fired power plants to “rare circumstances” and urged multilateral development banks to follow its lead. In late 2013, the U.S. Treasury Department [announced](#) that it would no longer vote in multilateral development banks to approve financing for conventional coal plants abroad except in rare circumstances. New plants abroad would have to meet the same emission standards as that imposed on new coal plants built in the United States. In 2013, the U.S. Export-Import Bank also [adopted](#) new guidelines to no longer finance most overseas coal projects unless they have carbon capture. (Republicans in the U.S. Congress [expanded the number of exceptions](#) and the issue is currently tied up in the broader fight over the reauthorization of the Export-Import Bank.)

Coal and Security

The United States has the largest [coal reserves](#) in the world by a substantial margin. Many proponents of coal point to it as an abundant, secure, domestic source of energy and argue that favoring coal over other sources of energy promotes greater U.S. energy security. While it is true that the United States has more coal on an energy-equivalent basis than the Middle East does oil, coal is not a perfect substitute for oil and converting coal into liquid form is technologically difficult, carbon-intensive, and expensive. The prospect that coal could replace oil in

the transportation sector is extremely unlikely. An eventual pathway for coal to play a role in the transportation sector is through providing power for electric vehicles, but there are economic, technological, and environmental issues associated with that pathway as well.

More fundamentally, energy security cannot be assured by security of supply alone. Diversity of supply sources, fungibility, price stability, affordability, reliability, and availability of infrastructure are also key components of energy security. Coal has many advantages, including a large and accessible supply base, safe and wide transportation networks, and low, stable prices. But while coal is a key component of U.S. and [global energy security](#), no single energy source alone guarantees a nation's energy security.

Coal: Other Policy Issues

Beyond emissions, there are other concerns related to coal production and use, including labor issues, [mine safety](#), acid mine drainage, [water use and quality](#), [methane emissions from active and abandoned mines](#), [mountaintop mining](#), and environmental degradation resulting from surface mines. Non-carbon air emissions from coal plants and solid [coal plant waste](#) are ongoing concerns among many in the environmental and health communities, and the U.S. Environmental Protection Agency has introduced new regulations in recent years to address those concerns (e.g., the Mercury and Air Toxics Standards and the coal ash rule). The regulation of toxic coal ash is a more prominent concern in the wake of a significant release of coal ash into a North Carolina river in 2014.

In addition, air quality related to coal-fired power generation is a persistent concern globally. For example, the extreme and persistent air quality issues in China have led Chinese policymakers to aggressively address air pollution by closing that country's most inefficient and polluting coal-fired power plants. China is also increasing its air quality standards and promoting other forms of power

generation to significantly reduce its reliance on coal-fired power in the future.

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