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## India

Last Updated: June 26, 2014 ([Notes](#))

[full report](#)

### Overview

*India was the fourth-largest energy consumer in the world after China, the United States, and Russia in 2011, and despite having notable fossil fuel resources, the country has become increasingly dependent on energy imports.*

India was the fourth-largest energy consumer in the world after [China](#), the United States, and [Russia](#) in 2011, and its need for energy supply continues to climb as a result of the country's dynamic economic growth and modernization over the past several years. India's economy has grown at an average annual rate of approximately 7% since 2000, and it proved relatively resilient following the 2008 global financial crisis.

The latest slowdown in growth of emerging market countries and higher inflation levels, combined with domestic supply and infrastructure constraints, have reduced India's annual inflation-adjusted gross domestic product (GDP) growth from a high of 10.3% in 2010 to 4.4% in 2013, according to the International Monetary Fund (IMF). India was the third-largest economy in the world in 2013, as measured on a purchasing power parity basis. Risks to economic growth in India include high debt levels, infrastructure deficiencies, delays in structural reforms, and political polarization between the country's two largest political parties, the Indian National Congress and the Bharatiya Janata Party (BJP).

The BJP, elected as the majority party in May 2014 to govern India in the following five years, faces challenges to meet the country's growing energy demand by securing affordable energy supplies and attracting investment for infrastructure development. Highly regulated fuel prices for consumers, fuel subsidies that are shouldered by the government and state-owned upstream companies, and inconsistent energy sector reform currently hinder energy project investment. Some parts of the energy sector, chiefly coal production, remain relatively closed to private and foreign investment, while others such as electric power, petroleum and other liquids, and natural gas have regulated price structures that discourage private investment.

Despite having large coal reserves and a healthy growth in natural gas production over the

past two decades, India is increasingly dependent on imported fossil fuels. In 2013, India's former petroleum and natural gas minister, Veerappa Moily, announced that his ministry would work on an action plan to make India energy independent by 2030 through increased fossil fuel production, development of resources such as coalbed methane and shale gas, foreign acquisitions by domestic Indian companies of upstream hydrocarbon reserves, reduced subsidies on motor fuels, and oil and natural gas pricing reforms. The current petroleum and natural gas minister, Dharmendra Pradhan, who took office in late May 2014, reiterated the goal of making India self-sufficient in energy resources. India is also looking to further develop and harness its various renewable energy sources. These actions would effectively increase India's energy supply and create more efficiency in energy consumption. India already began implementing oil and gas pricing reforms over the past two years to foster sustainable investment and help lower subsidy costs.

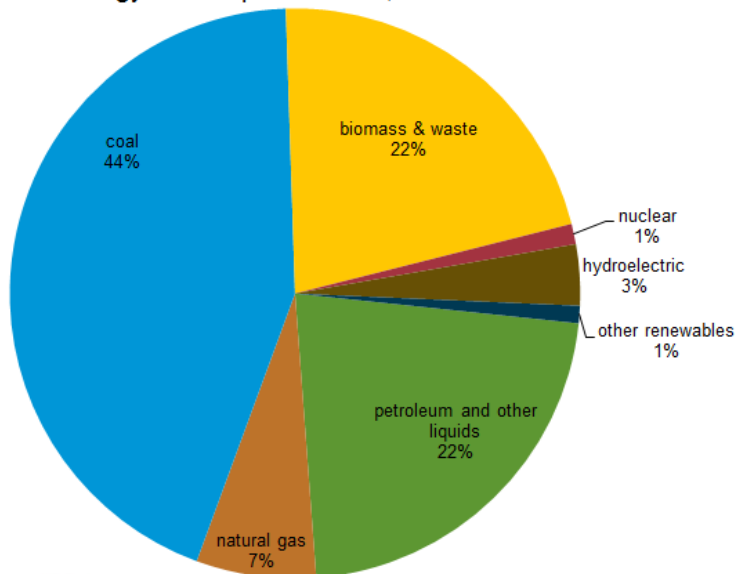
Primary energy consumption in India has more than doubled between 1990 and 2012, reaching an estimated 32 quadrillion British thermal units (Btu). The country has the second-largest population in the world, at more than 1.2 billion people in 2012, growing about 1.3% each year since 2008, according to World Bank data. At the same time, India's per capita energy consumption is one-third of the global average, according to the International Energy Agency (IEA), indicating potentially higher energy demand in the long term as the country continues its path of economic development. In the International Energy Outlook 2013, EIA projects India and China will account for about half of global energy demand growth through 2040, with India's energy demand growing at 2.8% per year.

India's largest energy source is coal, followed by petroleum and traditional biomass and waste. Since the beginning of the New Economic Policy in 1991, India's population increasingly has moved to cities, and urban households have shifted away from traditional biomass and waste to other energy sources such as hydrocarbons, nuclear, biofuels, and other renewables. The power sector is the largest and fastest-growing area of energy demand, rising from 22% to 36% of total energy consumption between 1990 and 2011, according to the IEA. India's National Sample Survey Organization estimates that about 25% of the population (over 300 million people) lack basic access to electricity, while electrified areas suffer from rolling electricity blackouts. The government seeks to balance the country's growing need for electricity with environmental concerns from the use of coal and other energy sources to produce that electricity. India's transportation sector, primarily fueled by petroleum products, is set to expand as the country focuses on improving road and railway transit. The government plans to mandate some alternative fuel use, particularly with biofuel blends, and develop greater use of mass transit systems to limit oil demand growth.



Source: U.S. Energy Information Administration  
 Representation of international boundaries and names is not necessarily authoritative.

Total energy consumption in India, 2012



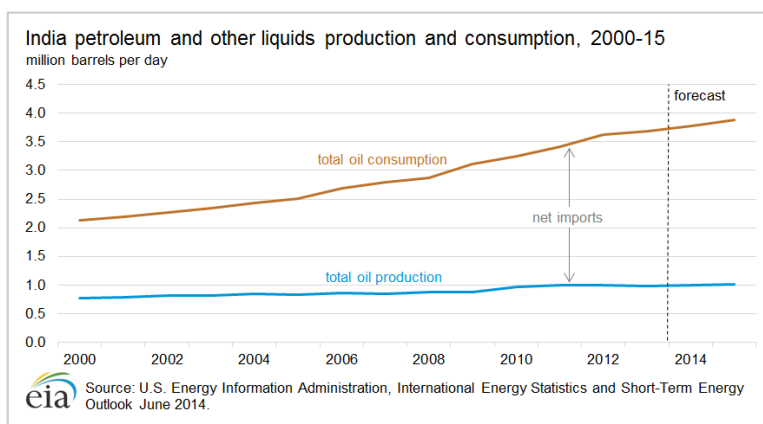
Source: U.S. Energy Information Administration, International Energy Agency, BP Statistical Review.

## Petroleum and other liquids

*India was the fourth-largest consumer of crude oil and petroleum products in the world in 2013, after the United States, China, and Japan. The country depends heavily on imported crude oil,*

*mostly from the Middle East.*

India was the fourth-largest consumer of oil and petroleum products after the United States, China, and Japan in 2013, and it was also the fourth-largest net importer of crude oil and petroleum products. The gap between India's oil demand and supply is widening, as demand reached nearly 3.7 million barrels per day (bbl/d) in 2013 compared to less than 1 million bbl/d of total liquids production. EIA projects India's demand will more than double to 8.2 million bbl/d by 2040, while domestic production will remain relatively flat, hovering around 1 million bbl/d. The high degree of dependence on imported crude oil has led Indian energy companies to diversify their supply sources. To this end, Indian national oil companies (NOCs) have purchased equity stakes in overseas oil and gas fields in South America, Africa, Southeast Asia, and the Caspian Sea region to acquire reserves and production capability. However, the majority of imports continue to come from the Middle East, where Indian companies have little direct access to investment.



## Sector organization

*India's upstream petroleum liquids industry is still mainly owned by state-owned firms, although the sector is open for competition and attracts some level of private and foreign investment. The government regulates the fuel price for petroleum products, although the mounting costs of fuel subsidies in recent years have encouraged the government to lift retail price caps on some oil products.*

Almost two decades after nationalizing the country's hydrocarbon resources in the 1970s, the Indian government embarked on the New Economic Policy in 1991 that pushed for open market competition across a variety of energy sectors. The government introduced the New Exploration Licensing Policy (NELP) in 1999 that allowed investors to bid on development blocks with up to 100% foreign control. Currently, the government is preparing to issue the 10th round of bidding for the NELP after more than two years of awarding contracts for the 9th round of the NELP. The 9th round resulted in 13 contracts signed (1 for each block awarded) out of 34 blocks that were offered.

International investment is still relatively low, and most analysts agree that the NELP has had only limited success in reducing India's oil dependence. India is offering 46 exploration blocks under the new NELP round, including 17 onshore, 15 shallow-water, and 14 deepwater blocks. The round was scheduled to officially open in February 2014, although the government is in the process of determining the structure of petroleum contracts between the government and companies. The current system includes a production-sharing mechanism allowing producers to recover exploration costs during production before

sharing profits with the government.

The Ministry of Petroleum and Natural Gas (MOPNG) regulates the entire value chain of the oil sector, including exploration and production (E&P), refining, supply, and marketing. The ministry releases five-year plans that serve as rough guidelines to the energy sector. Under the MOPNG, the Directorate General of Hydrocarbons regulates the upstream side of the oil sector, as well as coalbed methane (CBM) projects. Another sub-ministry, the Petroleum and Natural Gas Regulatory Board (PNGRB), acts as a downstream regulator, including petroleum product sales and distribution.

Until 2002, the government set the price of petroleum products through the Administered Pricing Mechanism (APM), which followed the principle of allowing a predetermined return (rather than market-based prices) on investments in the oil sector. After 2002, only certain products (namely kerosene and liquefied petroleum gases, or LPG, often used for cooking or home heating) remained regulated, while oil companies could set their own prices for other fuels. However, many oil marketing companies still set retail prices at below-market levels so they could claim under-recoveries (the difference between a global market price and the local price) from the Ministry of Finance for certain products at favorable rates. The government began domestic fuel price reform and officially deregulated gasoline prices in June 2010 (to take effect in 2012). High international oil prices in recent years and growing demand for oil products have increased the country's fiscal deficit as a result of its mounting fuel subsidy bill. In January 2013, India began a phased deregulation of retail diesel prices each month to reduce some of the country's subsidies.

Competition in the oil sector is now relatively open, particularly when it comes to the upstream market. On one hand, two state-owned companies, the Oil and Natural Gas Corporation (ONGC) and Oil India Limited (OIL), control the majority of production and refining activity in India. ONGC is India's largest oil producer, accounting for about 69% of the domestic production in 2012 according to the company's annual report. On the other hand, the government has slowly reduced its share of ownership in ONGC in an effort to raise revenue, and several private companies have emerged as important players in the past decade. Cairn India, a subsidiary of British company Cairn Energy, controls more than 20% of India's crude oil production through its operation of major stakes in the Rajasthan and Gujarat regions and the Krishna-Godavari basin. Private companies like Reliance Industries (RIL) and Essar Oil have become major refiners. Other international oil companies have few stakes in the Indian oil market.

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## Exploration and production

*India held nearly 5.7 billion barrels of proved oil reserves at the beginning of 2014, mostly in the western part of the country. Domestic production has not kept pace with demand in recent years, leading to exploration of deepwater and marginal fields and investment in improving recovery rates of existing fields. In addition, Indian national oil companies are purchasing more upstream stakes in overseas oil fields to increase supply security from imported crude oil.*

According to the *Oil & Gas Journal* (OGJ), India held nearly 5.7 billion barrels of proved oil reserves at the beginning of 2014. About 44% of reserves are onshore resources, while 56% are offshore. Most reserves are found in the western part of India, particularly the Western offshore area near Gujarat and Rajasthan. The Assam-Arakan basin in the northeastern part of the country is also an important oil-producing region and contains more than 23% of the

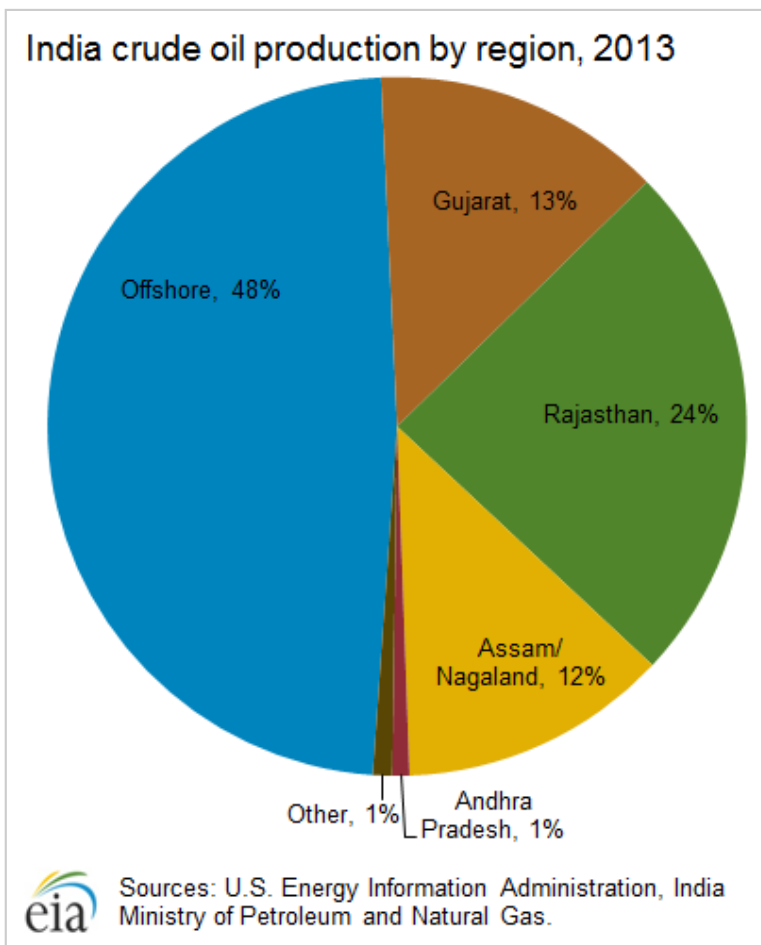
country's reserves and 12% of the production.

Historically, ONGC dominated the upstream oil sector and relied on production from Mumbai High basin and its associated fields in the western offshore area. India's total petroleum and other liquids production increase has been very gradual during the past two decades, growing at less than 2% total and peaking at 996,000 bbl/d in 2011. Production has declined slightly to 982,000 bbl/d in 2013. The Mumbai High, Gujarat, and Assam-Arakan basins contain mature fields experiencing production declines, although several redevelopment projects, enhanced oil recovery efforts, and marginal field development projects in these basins are underway to lift production by 2030.

Indian and foreign companies are investing in more frontier developments and marginal fields to help offset production declines from mature basins. In recent years, major discoveries in the Barmer basin in Rajasthan and the offshore Krishna-Godavari basin by smaller companies such as Gujarat State Petroleum Corporation and Andhra Pradesh Gas Infrastructure Corporation hold some potential to diversify the country's production.

India's relatively small land-based resource endowment means companies require more upstream technical expertise to tap into offshore reserves, especially in technically challenging deepwater reserves. Foreign companies historically took the lead in exploring new offshore opportunities. For example, Cairn India brought online the largest field, Mangala, of the RJ-ON-90/1 block in Barmer basin in 2009, with a production capacity of 130,000 bbl/d. The Rajasthan fields, including Mangala, produced 179,000 bbl/d in 2013, according to FACTS Global Energy (FGE), and Cairn India reports production from the fields could peak at 300,000 bbl/d. Despite Cairn's successful drilling in Rajasthan, foreign investment in India has waned in recent years, both because of increased competition from domestic Indian companies and India's complex exploration and production laws.

The government has encouraged companies to acquire overseas upstream assets as a way to shield the domestic energy sector from global price volatility. Indian companies hold large stakes in [Sudan's](#) GNOP block, [Russia's](#) Sakhalin-1 project, and [Venezuela's](#) San Cristobal and Carabobo blocks. Amerada Hess Corporation sold key oil fields in Azerbaijan to ONGC in 2012. Also, ONGC, OIL, and RIL have taken stakes in gas plays in Mozambique, shale gas assets in the United States and [Canada](#), and oil and gas assets in Myanmar, and the companies are actively pursuing other overseas upstream deals. In 2011, several government agencies agreed to establish a sovereign wealth fund that could also aid in financing overseas energy acquisitions.



## Downstream and refining

*India's government promotes the country's refining sector, and India became a net exporter of petroleum products in 2001. India has several world-class refineries, and the private sector has significant investments in the country's refining industry.*

India's government started encouraging energy companies to invest in refineries at the end of the 1990s, and the investment helped the country become a net exporter of petroleum products in 2001. In particular, the government eliminated customs duties on crude imports, lowering the cost of fuel supply for refiners. These reforms made domestic production of petroleum products more economic for Indian companies. In its 11th Five Year Plan (2007-2012), India's government set the goal of making India a global exporting hub of refined products.

However, India still imports kerosene and liquefied petroleum gas (LPG) products for domestic use, and some export-oriented refineries began reorienting production for domestic use in 2009 to help ease shortages of motor gasoline, gasoil, kerosene, and LPG. These products make up 73% of India's petroleum product consumption, according to FGE. In particular, many rural areas of India use LPG and kerosene along with traditional biomass as cooking fuels (see Biomass and Waste below). The government is encouraging a shift from kerosene used in cooking fuel in rural areas to LPG, a cleaner and less-expensive fuel. Liquid fuels have competed with natural gas in the past few years as the power and fertilizer industries are using natural gas as a substitute for some naphtha and fuel oil supply. Diesel remains the most-consumed oil product, accounting for 42% of petroleum product consumption in 2013.

The refining industry is an important part of India's economy, and the private sector owns about 38% of total capacity. At the end of 2013, India had 4.35 million bbl/d of refining capacity, making it the second-largest refiner in Asia after China, according to FGE. The two largest refineries by crude capacity, located in the Jamnagar complex in Gujarat, are world-class export facilities and are owned by Reliance Industries. The Jamnagar refineries account for 29% of India's current capacity. These refineries are close to crude oil-producing regions in the Middle East, which allows them to take advantage of lower transportation costs.

India projects an increase of the country's refining capacity to 6.3 million bbl/d by 2017 based on its current five-year plan to meet rising domestic demand and export markets, although this projection hinges on all proposed projects becoming operational. Some refinery projects have faced delays in the past few years, and there is now greater competition within Asia from countries such as China that has built large refineries able to process more complex crude oil types. Two refineries, Paradip in Odisha and Cuddalore in the southern state of Tamil Nadu, are scheduled to be operational by 2015, adding 420,000 bbl/d of capacity. Also, refiners have plans to upgrade several existing refineries to produce higher-quality auto fuels to comply with more stringent specifications for vehicle fuel standards. India plans to adopt the equivalent of [Euro IV fuel efficiency standards](#) on a nationwide basis by 2015 and [Euro V standards](#) on passenger cars by 2016. Refineries have proposed several expansions to existing facilities and a few new refineries by 2020, although the timeline of these projects depends on economic recovery and fuel sales in both domestic and export markets.

## India refining sector

Refinery location	Name of company	Crude refining capacity (1,000 barrels/day)
<b>Public Sector</b>		
Barauni, Bihar	Indian Oil Corp. Ltd.	120
Bongaigaon, Assam	Indian Oil Corp. Ltd.	47
Digboi, Assam	Indian Oil Corp. Ltd.	13
Guwahati, Assam	Indian Oil Corp. Ltd.	20
Haldia, West Bengal	Indian Oil Corp. Ltd.	151
Koyali, Gujarat	Indian Oil Corp. Ltd.	275
Mathura, Uttar Pradesh	Indian Oil Corp. Ltd.	160
Panipat, Haryana	Indian Oil Corp. Ltd.	301
Mahul, Mumbai	Hindustan Petroleum Corp. Ltd. (HPCL)	131
Visakhapatnam, Andhra Pradesh	Hindustan Petroleum Corp. Ltd. (HPCL)	166
Mahul, Mumbai	Bharat Petroleum Corp. Ltd.	241
Kochi, Kerala	Bharat Petroleum Corp. Ltd.	191
Manali, Chennai	Chennai Petroleum Corp. Ltd.	211
Nagapattinam, Tamil Nadu	Chennai Petroleum Corp. Ltd.	20
Numaligarh, Assam	Numaligarh Refinery Ltd.	60
Mangalore, Karnataka	Mangalore Refinery & Petrochemicals Ltd.	302
Tatipaka, Andhra Pradesh	Oil & Natural Gas Corp. Ltd. (ONGC)	1



(UNGC)

<b>Joint-Venture</b>		
Bina, Madhya Pradesh	Bharat-Oman Refinery Ltd.	120
Bathinda, Punjab	HPCL-Mittal Energy Ltd.	180
<b>Private Sector</b>		
Jamnagar	Reliance Industries Ltd.	660
SEZ, Jamnagar	Reliance Industries Ltd.	580
Vadinar, Gujarat	Essar Oil Ltd.	405
Total		4,351

Note: SEZ = Special Economic Zone

Sources: U.S. Energy Information Administration, India Ministry of Petroleum & Natural Gas, Oil & Gas Journal, FGE.

## Trade

*India is a significant importer of crude oil, as the country's demand growth continues to outstrip domestic supply growth. The Middle East was the major source of crude oil imports to India in 2013, although the Western Hemisphere's share has risen in recent years.*

India has increased its total net oil imports from 42% of demand in 1990 to an estimated 71% of demand in 2012. India's demand for crude oil and petroleum products is projected to continue rising, barring a serious global economic recession. Oil import dependence will continue to climb if India fails to achieve production growth equal to demand growth.

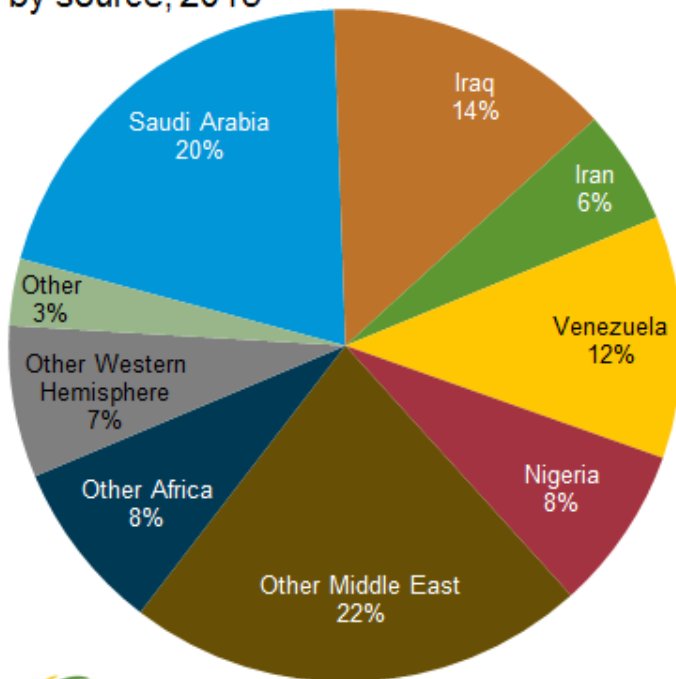
The Indian Ocean historically has been a major transit route, bringing crude oil from suppliers in the Persian Gulf and Africa to markets in Asia. Tanker sea lanes pass near Indian waters between major chokepoints such as the Strait of Malacca and the Strait of Hormuz (see the [World Oil Transit Chokepoints](#) report). The majority of Indian oil ports are located on the country's western side to receive shipments of crude oil that passes through these routes.

India's crude oil imports reached nearly 3.9 million bbl/d in 2013, according to Global Trade Atlas. Saudi Arabia is India's largest oil supplier, with a 20% share of crude oil imports. In total, approximately 62% of India's imported crude oil came from Middle East countries. The second-biggest source of imports is the Western Hemisphere (19%), with the majority of that crude oil coming from Venezuela. Africa contributed 16% of India's crude oil imports. Supply disruptions in several countries, including [Iran](#), [Libya](#), Sudan, and Nigeria, in tandem with India's growing dependence on imported crude oil, have compelled India to diversify its crude oil import slate. Iran accounted for 5.5% of India's crude imports in 2013, down from 8.3% in 2011-12 as a result of the U.S. and European sanctions imposed on Iranian oil exports. Also, Indian refiners are trying to reduce crude oil import costs by purchasing less expensive crude oil. Prices of Middle Eastern crude oil grades in the past year have been high relative to prices of oil from the Western Hemisphere, prompting Indian companies to import more crude oil from Latin America, primarily from Venezuela, [Colombia](#), and [Mexico](#).

Despite being a net importer of crude oil, India has become a net exporter of petroleum products by investing in refineries designed for export, particularly in Gujarat. Essar Oil and RIL export naphtha, motor gasoline, and gasoil to the international market, particularly to [Singapore](#), [Saudi Arabia](#), the [United Arab Emirates](#), and the Netherlands. Reliance

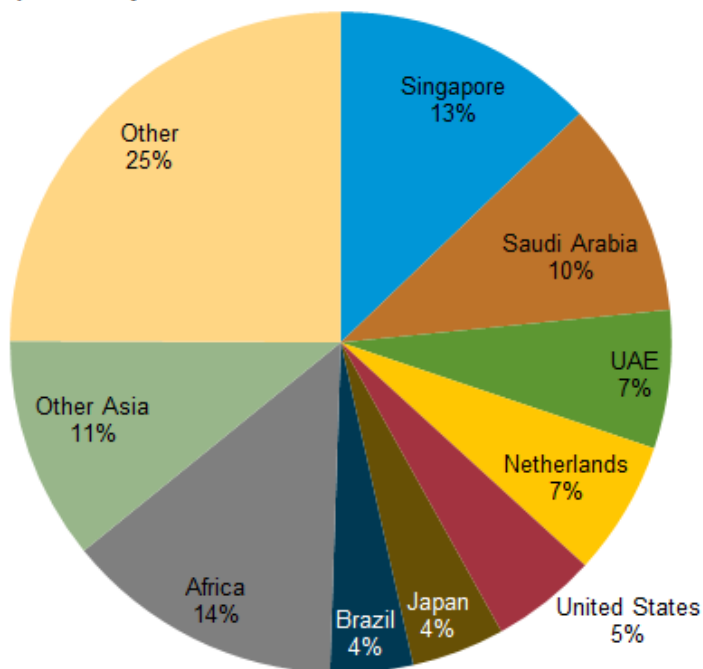
Industries has also targeted U.S. markets and leased storage space in New York harbor in 2008. However, the government encourages the companies to focus on supplying domestic markets before selling abroad.

### India petroleum and other liquids imports by source, 2013



Source: U.S. Energy Information Administration, Global Trade Atlas.

### India motor fuel, kerosene, jet fuel, and naphtha exports by destination, 2013



Source: U.S. Energy Information Administration, Global Trade Atlas.

## Pipelines and infrastructure

According to the Ministry of Oil and Natural Gas, India's crude oil pipeline network spans just under 5,900 miles and has a total capacity of 2.8 million bbl/d. Approximately 30 terminals, mostly on the northwest coast, take in crude oil imports. Pipelines run from these ports and producing areas (particularly from Gujarat) to major oil refineries in Gujarat, Mathura, Uttar Pradesh, and Haryana. On the eastern part of the country, pipelines run from West Bengal to the Paradip oil refinery. Refineries are generally located in coastal areas, because the majority of crude oil comes from tanker imports and offshore fields. Central and southern areas have few major pipelines, because the bulk of refining capacity is in the northwest and northeast.

The Indian Oil Corporation (IOC) controls and operates the oil product pipelines and supplies most of the oil products going to the domestic market. Oil product pipelines cluster in the north and northeast parts of India, while central and southern areas must rely on oil distributed through other means, such as cargo trucks. IOC plans to build additional crude oil and product lines including one to move supplies from its Paradip refinery in the eastern Odisha state to growing demand centers in Odisha and adjacent states of Jharkhand and Chhattisgarh.

### India liquid fuels infrastructure



Source: U.S. Energy Information Administration, IHS Edin  
Representation of international boundaries and names is not necessarily authoritative.

## Strategic petroleum reserve

In 2005, the Indian Government decided to set up strategic storage of 37 million barrels of crude oil at three locations (Visakhapatnam, Mangalore, and Padur). The Indian Strategic Petroleum Reserves Limited (ISPRL), a special purpose legal entity owned by the Oil Industry Development Board, would manage the proposed facilities, which are expected to be completed by 2015. The government unveiled plans to add another 91 million barrels to the state's crude oil capacity to protect India from supply disruptions by 2017. The country anticipates having crude oil stocks to cover 90 days of the country's oil demand by 2020.

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## Natural gas

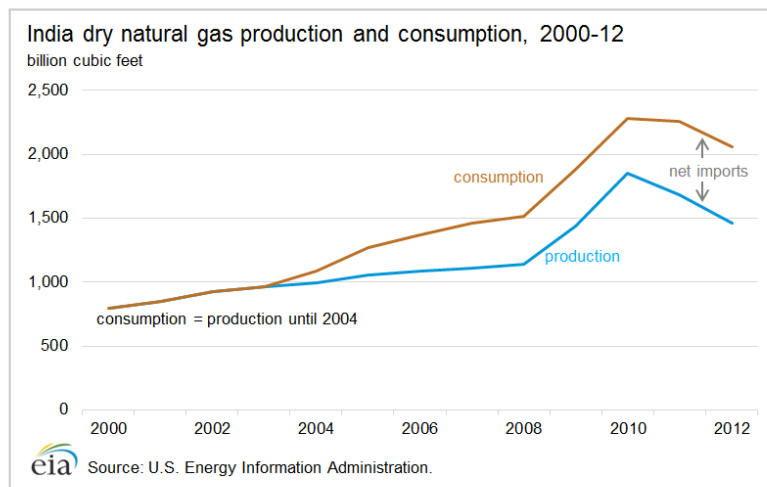
*Natural gas serves as a substitute for coal in electricity generation and fertilizer production in India. The country began importing liquefied natural gas from Qatar in 2004 and increasingly relies on imports to meet domestic natural gas needs.*

Natural gas mainly serves as a substitute for coal for electricity generation and as an alternative for LPG and other petroleum products in the fertilizer and other sectors. The country was self-sufficient in natural gas until 2004, when it began to import liquefied natural gas (LNG) from [Qatar](#). Because it has not been able to create sufficient natural gas infrastructure on a national level or produce adequate domestic natural gas to meet domestic demand, India increasingly relies on imported LNG. India was the world's fourth-largest LNG importer in 2013, following Japan, [South Korea](#), and China, and consumed almost 6% of the global market, according to data from IHS Energy. Indian companies hold both long-term supply contracts and more expensive spot LNG contracts.

Natural gas consumption has grown at an annual rate of 8% from 2000 and 2012, although supply disruptions starting in 2011 resulted in declining consumption. Natural gas consumption in India was tied closely to domestic production until imports became available in 2004. In 2012, India consumed 2.1 trillion cubic feet (Tcf) of natural gas. LNG imports accounted for about 29% of 2012 demand, and LNG is expected to account for an increasing portion of demand at least in the next several years as Indian energy firms attempt to reverse the country's recent domestic production declines. Increasing LNG imports will depend on the pace of expansion in regasification terminal capacity and pipeline infrastructure connecting gas to markets that currently lack access. The country's pricing system is undergoing revision to unlock regulated prices that are well below the import price levels. Raising gas prices would provide oil and gas firms with economic incentives for upstream development, especially in deepwater plays and technically challenging fields, and would allow LNG importers to compete more effectively for gas consumers in a higher-priced environment.

The majority of natural gas demand in 2012 came from the power sector (33%), the fertilizer industry (28%), and the replacement of LPG for cooking oil and other uses in the residential sector (15%), according to India's MOPNG. The government has labeled these as priority sectors for domestic programs, which ensures that they receive larger shares of any new gas supply before other consumers. The fertilizer sector, which is highly price-sensitive, has been able to maintain low fuel costs by using natural gas. The recent unexpected natural gas production declines since 2011 have forced electric generators to seek fuel alternatives, primarily coal. The government is promoting the use of natural gas in the residential sector

as an alternative to LPG as a cooking fuel.



## Sector organization

*In 2013, India began natural gas pricing reforms, and the government approved a new pricing scheme to further align domestic prices with international market prices and to raise investment for the sector.*

As with the oil sector, India's Ministry of Petroleum and Natural Gas (MOPNG) oversees natural gas exploration and production activities. MOPNG's Directorate of Hydrocarbons functions as an upstream regulator and monitors coalbed methane projects. Until 2006, the Gas Authority of India Limited (GAIL) functioned as a near-monopoly operating India's natural gas pipelines.

However, the government began to reform gas pricing and created the Petroleum Natural Gas Regulatory Board to regulate downstream activities such as distribution and marketing.

Different producers of natural gas have different pricing schemes in India. The government directly sets prices for public sector companies through the Administered Price Mechanism (APM), while joint-venture producers generally index their prices to international rates. LNG prices are completely market-driven and are about triple the price of the APM benchmark on average. The Indian government approved a new natural gas pricing regime in June 2013 in an effort to attract investment critical to increase domestic gas production and mitigate upstream project delays. Most of India's gas consumers pay rates that are much lower than the prices of imported gas. The proposed pricing scheme would more closely align India's gas prices to international market rates and attempt to create a more uniform pricing structure. The current APM benchmark rate of \$4.20 per million Btu would double under the new formula, according to industry sources. Although the pricing scheme was slated to take effect on April 1, 2014, India's oil ministry delayed the price increase until after the country's general elections when the new government is expected to review the new pricing system and determine its course of action.

New private companies such as Petronet LNG Limited have formed in recent years aiming to benefit from growing LNG imports in India by building regasification plants. Privately-owned RIL emerged as an important upstream player in the natural gas market after discovering significant reserves in the Krishna-Godavari basin in 2002. RIL also operates the important East-West gas pipeline from Andhra Pradesh to Gujarat.

International firms have some stake in the natural gas sector. BP owns part of the KG-D6 field in the Krishna-Godavari basin, and Royal Dutch Shell has invested in potential future LNG facilities.

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## Exploration and production

*India had 47 trillion cubic feet of natural gas reserves at the beginning of 2014, mostly located offshore. The two largest state-owned oil companies, ONGC and Oil India, dominate the country's upstream gas sector.*

According to the *Oil & Gas Journal*, India had 47 Tcf of proved natural gas reserves at the beginning of 2014. About 34% of total reserves are located onshore, while 66% are offshore, according to India's Ministry of Oil and Gas. In 2002, energy companies made a number of large gas discoveries in the Krishna-Godavari (KG) basin off of India's eastern coast, pushing up both the reserve base and production. However, production from some of the more mature fields have declined in recent years, and RIL cut the recoverable reserves of its two major gas fields in the major D6 block (D1 and D3) in the KG basin from 10.3 Tcf estimated in December 2006 to 3.1 Tcf in 2012 because of unexpected declines and reservoir performance problems.

Total gas production in India amounted to around 1.5 Tcf in 2012. The two biggest state-owned companies, ONGC and Oil India Ltd. (OIL), dominate India's upstream gas sector. ONGC operates the Mumbai High Field, which provides a large amount of India's natural gas supply. ONGC remains India's largest natural gas producer, accounting for 62% of the domestic production in 2012 as reported in the company's annual report. However, the government has encouraged private and foreign companies to enter the upstream sector in recent years. RIL is becoming a major upstream force because of natural gas discoveries in the Krishna-Godavari basin. RIL has a strategic partnership with BP, which has a 30% stake in 21 of RIL's production-sharing contracts. Other major international oil companies do not have significant investments in India's natural gas upstream sector. India's MOPNG estimates that gas production continued to decline during 2013.

The KG-D6 field came online in early 2009, ramping up production to hit a peak of more than 2.4 billion cubic feet per day (Bcf/d) or 876 Bcf per year (Bcf/y), in 2010. However, the field has experienced production shortfalls in recent years, and output dropped to 0.4 Bcf/d (146 Bcf/y) at the end of 2013. RIL and BP plan to tie in production from satellite fields and invest \$5-10 billion to restore the production of the D6 block to more than 2.1 Bcf/d (767 Bcf/y) by 2020.

ONGC and Gujarat State Petroleum Corporation Limited (GSPCL) are also developing several offshore areas in Krishna-Godavari basin. Another promising producing area is the Cambay basin in western India, where independent company Oilex has done some preliminary work assessing the potential for tight natural gas.

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## Coalbed Methane and Shale Gas

India began awarding coalbed methane (CBM) blocks for exploration in 2001, although it has taken more than a decade to begin producing at these fields. The Indian Ministry of Oil partnered with the U.S. Geological Survey (USGS) and ONGC to conduct a resource assessment and estimates anywhere between 9 and 92 Tcf of CBM resources both onshore

and offshore India. Foreign companies have largely been absent from CBM production, leaving domestic Indian companies struggling to attract enough expertise and technology to develop these resources. Great Eastern Energy Corporation (GEEC) has developed the Raniganj block in West Bengal, with an estimated 1 Tcf of gas potential. Essar Oil and RIL have also been developing blocks in Bengal, although there has not been any significant commercial production. Total CBM production in 2013 amounted to about 5.8 Bcf.

Companies are interested in exploring the Cambay basin in Gujarat, the Assam-Arakan basin in northeast India, and the Gondwana basin in Central India for shale gas resources, although there has been no commercial production or publicly released reserve figures. In its [2013 assessment](#) of global shale gas reserves, EIA estimates India has 96 Tcf of technically recoverable shale gas reserves. Joshi Technologies made the first shale oil discovery in Cambay Basin in mid-2010. India's oil ministry announced that the government will unveil a shale gas and oil policy in the near future and will begin to sell shale gas development blocks, although it has not made any awards to date.

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## Pipelines and infrastructure

The two most important companies operating India's large gas pipeline system are GAIL and Reliance Gas Transportation Infrastructure Limited (RGTIL). GAIL, the state-owned gas transmission and marketing company, operates two major gas pipelines in northwestern India with a combined length of 3,328 miles: the Hazira-Vijaipur-Jagadishpur (HVJ) line running from Gujarat to Delhi, and the Dahej-Vijaipur (DVPL) line. The company services primarily the northwestern region of India and makes up over 70% of the country's pipeline network. Reliance Gas Transportation Infrastructure (RGTIL, owned by RIL) is the biggest private investor in the gas transmission structure and brought the 881-mile East-West pipeline online in 2009 to link the promising KG-D6 gas field to GAIL's pipeline network and demand centers in the northern and western regions. However, RIL's East-West pipeline remains relatively underutilized as a result of lower-than-expected production from the KG-D6 field. Other players like Assam Gas Company and Gujarat State Petronet Limited (GSPL) have significant pipeline assets that service regional demand centers in northeastern India and Gujarat, respectively.

Insufficient pipeline infrastructure and lack of a nationally integrated system are key factors that constrain natural gas demand in India, although GAIL and other companies are investing in several pipeline projects. The country's natural gas pipeline network totaled over 9,200 miles in 2013, and the current Five Year Plan proposes expanding the gas network to 18,000 miles by 2017. GAIL plans to expand its network and further integrate southern India with the pipeline system in the northwest of the country. In early 2013, GAIL commissioned the 600-mile Dabhol to Bengaluru (Bangalore) pipeline, the first line to connect the southern part of the country to the national grid. GAIL also plans to build a pipeline from its newly commissioned LNG regasification terminal at Kochi in southwestern India to Mangalore and other parts of southern India, although regulatory and land rights issues have delayed the project.

The Indian government has considered importing natural gas via pipeline through several international projects, although many of these have proved unfeasible. In 2005, negotiations over a transnational pipeline between the Indian and Bangladesh governments fell through. In 2006, India withdrew from the Iran-Pakistan-India (IPI) pipeline project. However, the government still participates in a pipeline project to import natural gas from Turkmenistan to India. The Turkmenistan-Afghanistan-Pakistan-India (TAPI) project, also known as the Trans-

Afghanistan Pipeline, has seen a decade of discussion, although major geopolitical risks and technical challenges have prevented the project from actually starting. However, the countries have made some progress in moving TAPI forward. The partners signed a framework agreement in 2010 and agreed on unified transit tariffs for the route in early 2012. In May 2012, India signed gas supply and purchase agreements with Turkmenistan. In early February 2013, India's government approved a special-purpose legal entity to which participating members of the pipeline would contribute investment funds. In November 2013, the four participants appointed the Asian Development Bank (ADB) as the project's technical and financial advisor. The ADB estimated the pipeline's cost at about \$10-12 billion.

### India natural gas infrastructure



Source: U.S. Energy Information Administration, IHS Edin  
Representation of international boundaries and names is not necessarily authoritative.

## Liquefied natural gas

*Indian companies are investing in new regasification facilities to meet the country's rising natural gas demand. India was the world's fourth-largest liquefied natural gas importer in 2013.*

Liquefied natural gas (LNG) has become an important part of India's energy portfolio since the country began importing it from Qatar in 2004. In 2013, India was the world's fourth-largest LNG importer, importing 638 Bcf, or 6%, of global trade, according to data from IHS Energy. Petronet, a joint venture between GAIL, ONGC, IOC, and several foreign firms, is the major importer of LNG supplies to India. Petronet owns two existing LNG terminals, Dahej (480 Bcf/y) and Kochi (120 Bcf/y). Shell (74% share) and Total (26% share) jointly own the Hazira terminal (240 Bcf/y), which operates as a merchant facility, importing only short-term and spot cargoes at present. India's total regasification capacity now stands at 936 Bcf, and terminal owners have proposed capacity expansions at all existing terminals. Expansion under construction at Dahej will increase the terminal's capacity to 720 Bcf by 2016.

Unexpected production declines in India's KG-D6 gas field mean the country must rely on higher LNG imports. Average imported LNG prices have increased to three times the price of domestically produced natural gas because they are not subject to the government setting prices through the Administered Price Mechanism (see Sector Organization). Indian producers such as RIL have asked the government to raise the wellhead price for gas (the wholesale price at the point of production) as a way of justifying investment into deepwater



projects. If the proposed gas pricing reform is implemented, there will be greater investment incentives for domestic gas development that could increase competition for LNG imports.

Indian companies have invested in increasing the country's LNG regasification capacity in recent years to meet rising demand. In early 2013, GAIL, NTPC, and several other smaller players restarted the Dabhol project, originally proposed by now-defunct Enron, which includes a regasification terminal to fuel three gas-fired power stations. Dabhol LNG also ships natural gas to southern India through the new pipeline to Bengaluru. GAIL is installing a breakwater facility to double Dabhol's capacity by 2017. Petronet's LNG terminal at Kochi was commissioned in late 2013. However, the terminal is experiencing low utilization because of delays in the approval and construction of a proposed pipeline to Mangalore and other parts of southern India, according to PFC Energy. The eastern side of India lacks pipeline infrastructure and gas supply following declines in the KG basin; thus companies are quickly planning terminals to come online in the next few years. IOC proposed the Ennore project in Tamil Nadu in southeastern India. Other proposed projects are located along India's eastern coast include three floating terminal projects at Kakinada and one at Gangavaram. Several proposed regasification projects along the western coast include GSPC's Mundra terminal in Gujarat, expected to be built by 2016.

Qatar's RasGas is India's sole long-term supplier of natural gas, with two contracts for a total of 360 Bcf. In 2013, Qatar was the source of 84% of India's total LNG imports, according to IHS Energy. India has been an active importer of spot cargoes following interruptions in the KG-D6 field production after 2010 and began receiving LNG cargoes from a variety of exporting countries. [Nigeria](#), Egypt, and [Yemen](#) have become India's largest short-term LNG suppliers.

Indian LNG importers actively sought supply from various new LNG sources and signed several short- and long-term purchase agreements in the past few years. India signed agreements to receive supply from [Australia's](#) Gorgon LNG terminal and several U.S. terminals (Sabine Pass, Cove Point, and Main Pass) and from the portfolio of various global LNG suppliers such as BG, GDF Suez, Gas Natural Fenosa, and Gazprom. As Indian companies become more active in pursuing overseas upstream oil and gas plays, OIL has invested in gas projects in Canada (Pacific Northwest LNG) and an offshore gas project in [Mozambique](#) (jointly with ONGC) to secure LNG imports for India.

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## Coal

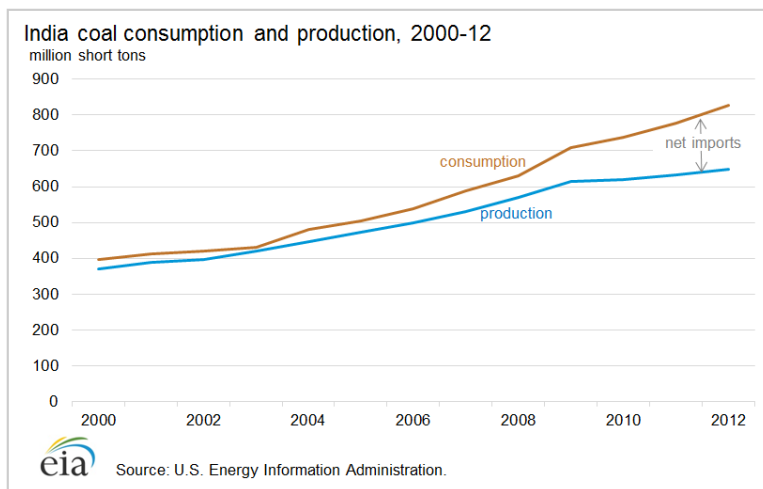
*Coal is India's primary source of energy. The country has the world's fifth-largest coal reserves, and ranked third largest in terms of both production and consumption in 2012. The state retains a near-monopoly on the coal sector. The power sector makes up the majority of coal consumption.*

Coal is India's primary source of energy, and the country was the third-largest global consumer in 2012. The country has the fifth-largest coal reserves in the world. At the same time, the coal sector is one of the most centralized and inefficient sectors in India. Two state-owned companies have a near-monopoly on production and distribution. The country also faces a widening gap between demand and supply. Although production has moderately increased by about 4% per year since 2007, producers have failed to reach the government's production targets. Meanwhile, demand grew more than 7% annually

between 2007 and 2012, and reached 826 million short tons in 2012. Because coal production cannot keep pace with demand, particularly from the power sector, India has met more of its coal needs with imports.

The power sector is the largest consumer of coal, accounting for 69% of coal consumption in 2011, according to the IEA. Because power plants rely so heavily on coal, coal shortages are a major contributor to shortfalls in electricity generation and consequent blackouts throughout the country. Also, coal demand has escalated in the past few years from the power sector, which encountered problems accessing natural gas supply and lower hydroelectricity-sourced generation during the weak monsoon season in 2012.

Steel and cement industries are also significant coal consumers. India has limited reserves of coking coal, which is an important raw material for steel production. The state of Jharkhand holds most of India's coking coal reserves, but it does not supply enough to meet the industry's needs. Because of this shortage, India imports large quantities of coking coal from abroad.



## Sector organization

India's government took control of the country's coal reserves with the 1973 Coal Mines Nationalization Act, establishing Coal India Limited (CIL) in 1975 as the state-owned sole producer and aggregating coal production and investment. After 1993 it tried to encourage foreign and private investment into the coal sector through the National Mineral Policy. By 2000, the government deregulated coal prices, allowing CIL and other companies to increase prices when there is a rise in the cost of production. However, the Ministry of Coal and Mines continues to control the distribution of coal resources and subsidies to various companies. In 2007, the government passed the New Coal Distribution Policy that attempted to allocate limited coal supplies to priority sectors, particularly the power and fertilizer industries, and India's 12th Five Year Plan calls for CIL to link indigenous coal production with part of the fuel requirements of power plant projects coming online by 2017.

CIL remains the country's largest coal producer; and they produced about 81% of the country's coal in 2012, according to the IEA. CIL underwent an initial public offering (IPO) in 2010 and divested 10% of its government share, India's largest IPO to date. Singareni Collieries Company Limited (SCCL), another public-owned company, was responsible for nearly 10% of the country's coal production in 2012, mainly to the southern region of the country, according to India's Ministry of Coal. Other smaller companies operate throughout

the country.

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## Exploration and production

*India ranks as the third-largest coal producer in the world. However, the country continues to experience regulatory, land acquisition, technical, and distribution challenges that limit production growth and create bottlenecks hindering efficient transportation of coal to key demand centers.*

India had 66.8 billion short tons of proven coal reserves in 2011, the fifth-largest in the world (third-largest reserves in anthracite and bituminous after the United States and China), according to the World Energy Council. The Indian Ministry of Coal estimated proven reserves to be 137 billion short tons in 2012. Indian coal typically has high ash, low sulfur content, and a low-to-medium calorific value.

Most coal reserves are located in the eastern parts of the country. Jharkhand, Chhattisgarh, and Odisha account for approximately 64% of the country's coal reserves, according to the IEA. Other significant coal-producing states include West Bengal, Andhra Pradesh, Madhya Pradesh, and Maharashtra.

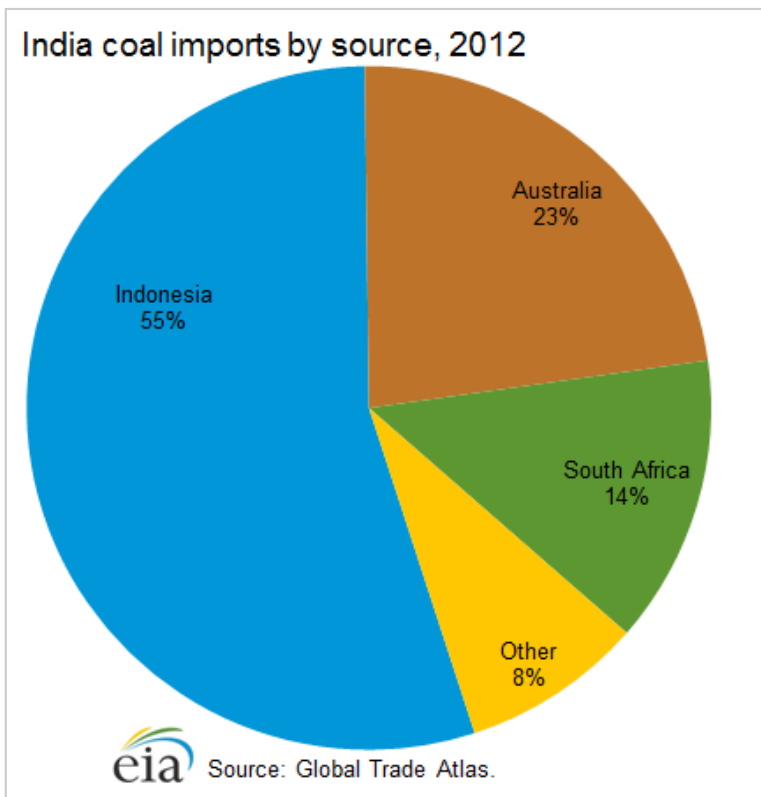
India is the third-largest global coal producer, with coal output nearly doubling between 2000 and 2012 to 650 million short tons. Despite its sizeable reserves and rising production, India has increasing supply shortages and systemic problems with its mining industry. According to an IEA report, about 90% of the country's coal mines are opencast, or surface, mines (less than 1,000 feet deep), which is more cost-effective and less dangerous for workers but causes more environmental impact. India lacks more advanced technology to engage in large-scale underground mining operations, which keeps productivity levels low. A lack of competition within the coal sector inhibits private and foreign investment that could be used to improve underground mining techniques. Also, many coal deposits are located in areas that pose environmental issues or potential dislocation of people. Regulatory hurdles continue to pose delays in obtaining environmental and land acquisition approvals for mining companies.

India's coal mines are also located far from the highest-demand markets in southern and western India, posing a significant logistical challenge to coal producers and distributors. Railcars transport the majority of Indian coal, according to CIL. Limited railway capacity, delays to railroad projects, and high transport costs to demand centers are other factors negatively affecting India's coal output and deliveries to users.

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## Trade

Although traditionally not a major importer of coal, India has imported small volumes of coking coal for over two decades to meet high demand in the steel and iron industry. The country's recent supply shortages spurred India's significant increase of coal imports over the past few years from several key exporting countries. India purchased 179 million short tons from overseas and was the third-largest coal importer behind China and Japan in 2012. India imports thermal (steam) coal used in power plants mainly from [Indonesia](#) and South Africa and coking coal for steel production from Australia. Indonesia is the largest source of coal imports to India, accounting for 55% of total coal imports in 2012.



## Electricity

*India had 249 gigawatts of installed electricity generation capacity connected to the national network in early 2014, mostly coal-powered plants. Because of insufficient fuel supply and power generation and transmission capacity, the country suffers from a severe electricity shortage, leading to rolling blackouts.*

As of May 2014, India had 249 gigawatts (GW) of utility-based installed electricity generating capacity, mostly from coal-fired power plants, according to India's Central Electricity Authority (CEA). Generation capacity from smaller captive power plants, or those that serve specific industries for in-house consumption and may not be connected to the grid, registered about 39 GW in 2014. According to the IEA, installed capacity from coal and natural gas power plants is heavily clustered in the more populated western region of the country, particularly in Maharashtra and Gujarat. For example, Maharashtra, the largest Indian state by GDP (its capital is Mumbai, the country's largest city), contains 14% of the nation's generating capacity. Hydropower is the second largest source of electricity, accounting for 16% of India's utility-based installed capacity in early 2014 and supplying about 13% of the country's electricity in 2011. The industrial sector has been a key driver of electricity consumption in the past decade, as a result of India's rapidly expanding economy.

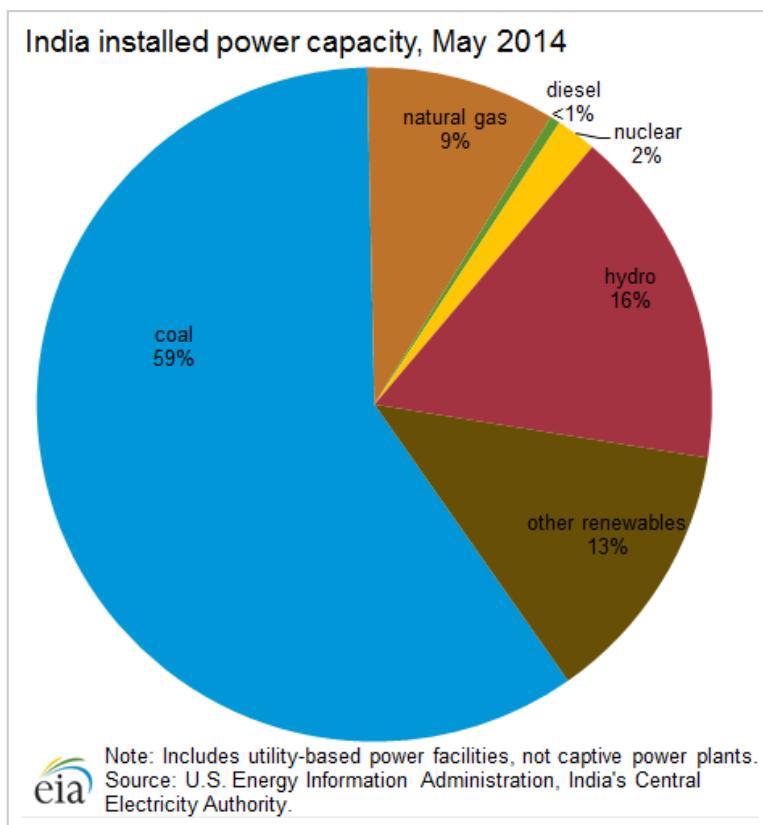
India suffers from severe shortages of electricity, particularly during peak hours of demand, and often experiences shut-downs lasting from several hours to days in certain areas. India suffered an unprecedented electricity blackout for two days in July 2012 that affected an estimated 680 million people across the country's northern states. This outage highlights the increasing pressure on India's power system to secure more fuel supplies and infrastructure investment in each stage of power transmission. Utilization rates in Indian power plants using fossil fuels have fallen steadily since 2007 (from a peak of nearly 79%) to about 70% in 2013 because of disruptions in steady domestic fuel supplies and transmission and

distribution constraints, according to the IEA and India's CEA. Deficiencies in coal and natural gas supply to power plants have caused some plant owners to curtail operations and even mothball some plants. Transmission and distribution losses and technical problems in moving electricity between various states also impair system reliability.

Other factors contributing to power shortages are the lag of power capacity expansions and the need to replace older, less efficient units. India has historically fallen short of its capacity addition targets for electricity, although the country has successfully attracted private investment for power plant construction in the past decade. In its 12th Five Year Plan (2012-17), India plans to add 120 GW of power capacity to the grid, with more than half of it composed of coal-fired generation capacity. By early 2014, more than a third of this capacity had been brought online.

In efforts to diversify the generation portfolio and offset some carbon dioxide emissions from fossil fuel sources, the government is promoting renewable energy use, with a 32-GW planned capacity expansion from sources such as wind, solar, biomass, and waste during the current Five Year Plan. For instance, India launched a national solar mission with a goal of adding 22 GW of solar capacity by 2022.

In addition, significant parts of the country, particularly in rural areas, do not have access to electricity. The Indian government reported overall household electrification in India was 75%, representing more than 300 million people without electricity, in 2011. While 94% of urban households had electricity, only 67% of rural households had access, and often the rural consumers experienced much more frequently interrupted electricity supply. The government began a program in 2005 called Rajiv Gandhi Grameen Vidyutikaran Yojana to provide all villages electricity within five years through significant investments in rural electrification. While the program has succeeded in electrifying many rural areas, power supply is unreliable and frequent blackouts persist.



India utility-based installed power capacity	Megawatts
<b>Source</b>	
Coal	147,568
Natural Gas	22,608
Petroleum and other liquids	1,200
Hydroelectricity	40,662
Nuclear	4,780
Other renewables	31,692
Total	248,509

Source: India's CEA.

## Sector organization

The Ministry of Power is responsible for planning and implementing India's power sector policy, with various subunits handling different parts of the sector, including thermal, hydropower, and distribution. The CEA advises the central government on long- and short-term policy planning. The Central Electricity Regulatory Commission and State Electricity Regulatory Commissions set generation and transmission policies.

The source of India's current electricity regulatory framework is the 2003 Electricity Act, which attempted to reform the state electricity boards, open access to transmission and distribution networks, and create state electricity regulatory commissions (SERCs) to manage electricity on a regional basis. Several key private investors, namely Reliance Power, Tata Power, and Essar Power, have entered India's power generation sector, and the share of private sector to state-run generation capacity is on the rise. The government has not fully implemented many parts of the Act, and India's electricity sector continues to face serious challenges in procurement and distribution of sufficient fuel for generation.

Power tariffs for end-users are highly regulated and kept low for the residential and agricultural sectors. Low retail prices often do not match higher generation costs, triggering financial losses for transmission and distribution companies and lower investment in electricity distribution. Higher costs from imported fuels and price swings in international fuel markets create financial constraints for power producers who cannot pass full costs to some of their customers. In order to mitigate supply risk from fuel sources with high price volatility and reduce carbon dioxide emissions growth, India's government is encouraging more generation from renewable energy sources.

The government established the Power Grid Corporation of India (POWERGRID) to operate five regional electricity grids, while state transmission utilities (with some private sector participation) run most transmission and distribution segments. Although the central government finances electricity development projects, delivering electricity to customers is the responsibility of state governments. Therefore, more-efficient states such as Maharashtra tend to have better electricity availability. The southern grid was integrated with the other four grids at the end of 2013, creating a more unified national grid. However, the transmission sector still requires substantial investment for capacity expansion as well as improved grid management to ensure power supply reliability across states and to reduce technical losses in transmission and distribution.

Different states also have varying energy mixes based on their natural resource endowment. For example, Gujarat is close to major gas fields and LNG terminals, allowing regional power plants to use a larger share of natural gas. Renewable power generation is concentrated in a few states so far. Wind power generation, which makes up the bulk of non hydroelectric renewable capacity, is found in southern states such as Tamil Nadu, and solar power generation is located in Gujarat and Rajasthan. Hydroelectricity is located mostly in the northeastern states.

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## Fossil fuels

Fossil fuel generation, mostly from coal, accounted for about 81% of total electricity generation in the country in 2011. Coal-fired power plants dominate India's electricity generation sector and accounted for nearly 148 GW (or 59%) of the utility-based installed capacity in early 2014. India plans to add more than 72 GW in fossil fuel-fired power capacity to the grid, with almost 70 GW from coal-fired stations, between 2012 and 2017. The government is attracting private investment for its Ultra-Mega Power Plants Program, which involves installing large-scale, coal-fired supercritical plants that are more energy-efficient for plant operations. Many of these plants are under construction, and about half of the proposed coal-fired capacity slated to come online during the 12th Five Year Plan (through 2017) are designed with more advanced technology. To alleviate fuel transportation constraints, these plants will be located near domestic coal supplies and the coasts to accommodate imports.

Natural gas fuels most of the remaining share of fossil fuel-fired electricity generation. After the newly developed Krishna Godavari basin (including the KG-D6 field) began producing significant amounts of natural gas and India began importing LNG during the past decade, natural gas use in power began to rise. Since 2011, natural gas-fired generation has waned, and some plants have ceased operation since the KG-D6 field production began to decline. Natural gas-fired generation capacity was nearly 23 GW in early 2014, or 9% of total generation capacity. The government's expansion plans for gas-fired capacity through 2017 are much lower compared to other fuel sources. It plans to use natural gas-fired power as a supply source for peak requirements.

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## Hydroelectric

India was the world's seventh-largest producer of hydroelectric power in 2012, with 115 billion kilowatthours generated. Total utility-based installed capacity of hydropower in early 2014 was nearly 41 GW, according to the CEA.

India benefits from a tropical climate, which gives the country increased hydropower potential, particularly during the summer months. In particular, states with significant river systems such as Himachal Pradesh, Jammu, Kashmir, and Uttarakhand benefit from energy surpluses as a result of abundant precipitation during the monsoon period. However, coal and natural gas generation is related inversely to hydropower capacity; when hydropower utilization falls, for example with a weak monsoon season, coal-fired power plants will generate more electricity to compensate for the shortfall. In 2012, India experienced a drought during the summer and saw a dip in hydroelectric generation which reversed in 2013 when the monsoon season was stronger than normal.

## Nuclear

India has 20 operational nuclear reactors at six nuclear power plants with a generation capacity of 4.8 GW, representing about 2% of total utility-based generation capacity. The Kudankulam plant in the southern state of Tamil Nadu was connected to the electricity grid at the end of 2013 and is expected to become operational in mid-2014 according to the Nuclear Power Corporation of India, adding another 1 GW to the country's nuclear capacity. As of April 2014, six additional reactors with a combined 4.3 GW of capacity are under construction and expected to come online by 2017. As India seeks reliable electricity supply to accommodate its swiftly growing power demand, the government has indicated that it plans to increase the nuclear share of total generation from 3% in 2011 to 25% by 2050.

In September 2008, India became a party to the Nuclear Suppliers' Group agreement, which opened access to nuclear technology and expertise through several cooperative agreements. The government has signed several such agreements with countries including the United States, Russia, [France](#), the United Kingdom, South Korea, and Canada. In addition, India gained access to reactor parts and uranium fuel from other countries as a result of these agreements.

Indians protested nuclear power after the Fukushima disaster in Japan, and the government responded by organizing safety audits for existing reactors. The Atomic Energy Regulatory Board (AERB) conducted stress tests of all nuclear power plants. The Indian government has a three-stage nuclear development plan to gradually shift from powering reactors with natural uranium to accumulating reserves of other fissile materials such as thorium. While the Indian nuclear sector historically has had limited access to uranium, it has abundant thorium reserves that can power more sophisticated reactors. India's commitment to the thorium fuel cycle sets it apart from most nations with nuclear power programs.

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## Biomass and waste

*The lack of electricity in some parts of India results in a substantial use of traditional biomass and waste products primarily for household uses in rural areas. A small portion of biomass and bagasse contributes to power plant feedstock.*

Rural areas of India tend to rely on traditional biomass (including firewood, animal dung, and agricultural residue) for cooking, heating, and lighting because they lack access to other energy supplies. These sources can be burned directly to produce heat and electricity.

Large parts of India rely on biomass as the primary fuel for cooking. According to the 2011 India census, 62.5% of rural households use firewood as the primary fuel for cooking, 12.3% use crop residue as the primary cooking fuel, and 10.9% use dung. By contrast, more than 3% of urban households use crop residue and dung, and only 20% use firewood as the primary fuel source for cooking. These uses can cause health problems from exposure to waste products and pollution or environmental problems when forests or crops are harvested unsustainably. On the whole, about 66% of India's total population used traditional biomass for cooking purposes in 2011, according to the IEA.

India also uses biomass in the power sector. According to the CEA, India had at least 3.4 GW of utility-based installed capacity in biomass power and bagasse-based cogeneration



plants as of mid-2013. India's Ministry of New and Renewable Energy reports the country has 18 GW of potential biomass electricity generation capacity and 5 GW of potential bagasse-based generation. A large amount of biomass used for electricity generation comes from bagasse (crushed sugarcane or sorghum stalks), which can be used in combustion-powered generators. Biodiesel and other liquid biofuels consumption in India is fairly low and mostly comes from several states that mandate 5% blending of ethanol in gasoline.

### India households by primary

#### fuel used for cooking Percentage

Fuel Type	Percentage		
	Total	Rural	Urban
Firewood	49.0	62.5	20.1
Crop residue	8.9	12.3	1.4
Cowdung cake	7.9	10.9	1.7
Coal, Lignite, Charcoal	1.4	0.8	2.9
Kerosene	2.9	0.7	7.5
Liquefied Petroleum Gases/Piped Natural Gas	28.5	11.4	65.0
Electricity	0.1	0.1	0.1
Bio-gas	0.4	0.4	0.4
Any other	0.5	0.6	0.2
No cooking	0.3	0.2	0.5

Source: India Census 2011

## Notes

- Data presented in the text are the most recent available as of June 26, 2014.
- Data are EIA estimates unless otherwise noted.

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