U.S. Energy Information Administration

‹ Countries

China

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full report

Overview

China is the world's most populous country with a fast-growing economy that has led it to be the largest energy consumer and producer in the world. Rapidly increasing energy demand, especially for petroleum and other liquids, has made China influential in world energy markets.

China has quickly risen to the top ranks in global energy demand over the past few years. China became the largest global energy consumer in 2011 and is the world's second-largest oil consumer behind the United States. The country was a net oil exporter until the early 1990s and became the world's second-largest net importer of crude oil and petroleum products in 2009. The U.S. Energy Information Administration (EIA) reports that China surpassed the United States at the end of 2013 as the world's largest net importer of petroleum and other liquids, in part because of China's rising oil consumption. China's oil consumption growth accounted for about 43% of the world's oil consumption growth in 2014. Despite China's slower oil consumption growth in the past few years, EIA projects China will account for more than one-fourth of the global oil consumption growth in 2015.

Natural gas use in China has also increased rapidly over the past decade, and China has sought to raise natural gas imports via pipeline and as liquefied natural gas (LNG). China is the world's top coal producer, consumer, and importer and accounts for almost half of global coal consumption, an important factor in world energy-related carbon dioxide emissions. China's rising coal production is the key driver behind the country becoming the world's largest energy producer in 2009. China's sizeable industrialization and swiftly modernizing economy helped the country became the world's largest power generator in 2011.

China is the world's most populous country (1.36 billion people in 2013) and has a rapidly growing economy, which has driven the country's high overall energy demand and the quest for securing energy resources.[1] According to the International Monetary Fund (IMF), China's annual real gross domestic product (GDP) growth slowed to a reported 7.4% in 2014, which was the lowest since 1990, after registering an average growth rate of 10% per year between 2000 and 2011.[2] China's leadership announced a target GDP growth rate of 7% for 2015. Chinese GDP, measured using purchase power parity (PPP) exchange rates, surpassed U.S. GDP in 2014, as estimated by IMF data.[3] (PPP exchange rates make adjustments for the differing costs of goods and services across countries, attempting to show what exchange rates would have to be to buy the same basket of goods in different places. As costs are much higher in the industrialized world, comparisons of GDP by PPP exchange rates tend to boost the relative size of economies in less developed nations.)

China mitigated the 2008 global financial crisis with a massive stimulus package spread over two years that helped bolster China's investments and industrial demand. Economic growth has slowed since 2012 as industrial production and exports decreased and as the government attempted to curb high debt levels and excessive investment in certain markets. In response to the rapidly slowing economy and deflationary trend in 2014, the government eased its monetary policy through interest rate cuts, providing medium-term loans to Chinese banks, and reducing the reserve requirements by banks. These measures have been followed by the government's announcement of a smaller, more strategic fiscal stimulus targeting infrastructure projects in 2015.[4]

New leadership emerged in China in March 2013 when Xi Jinping became President and Li Keqiang assumed premiership. The new administration is keen to initiate economic and financial reform in China in the interest of greater long-term and sustainable growth. In November 2013, at the Third Plenum, a major policy meeting held every five years, the Chinese government outlined broad principles for economic reform in China. The government is pursuing incremental policy and economic reforms to create more balanced economic growth and to shift away from an economy driven primarily by excessive investments and exports to an economy characterized by greater domestic consumption. In the energy sector, the government is moving toward more market-based pricing schemes, energy efficiency and pollution-controlling measures, and competition among energy firms, as well as making greater investments in more technically challenging upstream hydrocarbon areas and renewable energy projects. China has been seeking ways to attract more private investment in the energy sector by streamlining the project approval processes, implementing policies to foster more energy transmission infrastructure to link supply and demand centers, and relaxing some price controls.

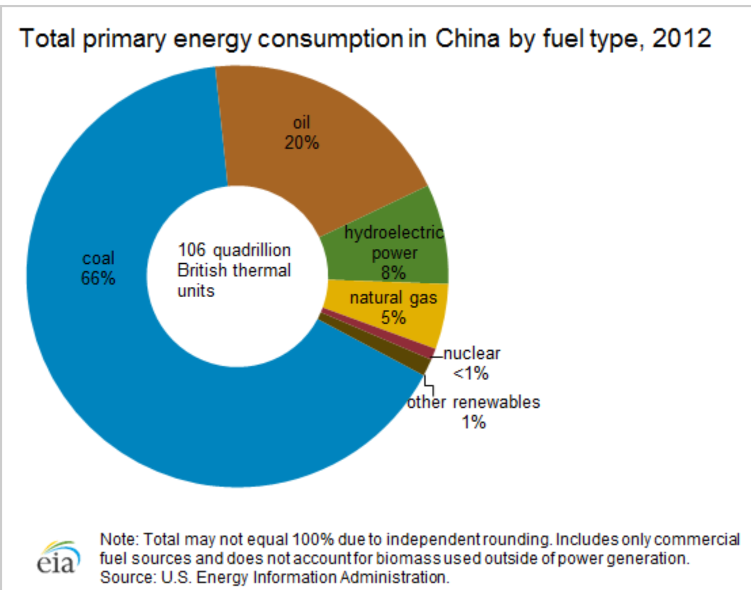
Map of China

Source: Central Intelligence Agency, *The World Factbook*

Total primary energy consumption

Coal supplied the majority (nearly 66%) of China's total energy consumption in 2012. The second-largest source was petroleum and other liquids, accounting for nearly 20% of the country's total energy consumption. Although China has made an effort to diversify its energy supplies, hydroelectric sources (8%), natural gas (5%), nuclear power (nearly 1%), and other renewables (more than 1%) accounted for relatively small shares of China's energy consumption. The Chinese government plans to cap coal use to 62% of total primary energy consumption by 2020 in an effort to reduce heavy air pollution that has afflicted certain areas of the country in recent years. China's National Energy Agency claims that coal use dropped to 64.2% of energy consumption in 2014.[5] The Chinese government set a target to raise non-fossil fuel energy consumption to 15% of the energy mix by 2020 and to 20% by 2030 in an effort to ease the country's dependence on coal. In addition, China is currently increasing its use of natural gas to replace some coal and oil as a cleaner burning fossil fuel and plans to use natural gas for 10% of its energy consumption by 2020.[6] Even though absolute coal consumption is expected to increase over the long term as total energy consumption rises, higher energy efficiency and China's goal to increase environmental sustainability are likely to lead to a decrease in coal's share.

As a result of high coal consumption, China is also the world's leading energy-related CO2 emitter, releasing 8,106 million metric tons of CO2 in 2012. China's government plans to reduce carbon intensity (carbon emissions per unit of GDP) by 17% between 2010 and 2015 and energy intensity (energy use per unit of GDP) by 16% during the same period, according to the country's 12th Five-Year Plan (2011-15). China also intends to reduce its overall CO2 emissions by at least 40% between 2005 and 2020. The current climate change plan released at the end of 2014 reinforced China's commitment to reduce carbon emissions mainly in the energy-intensive industries and in construction by 2020.[7] Recently, China projected that its carbon emissions would rise by more than one-third from current levels and peak in 2030.[8] These goals assume that China can reduce its reliance on coal and become a more energy-efficient economy in the long run.



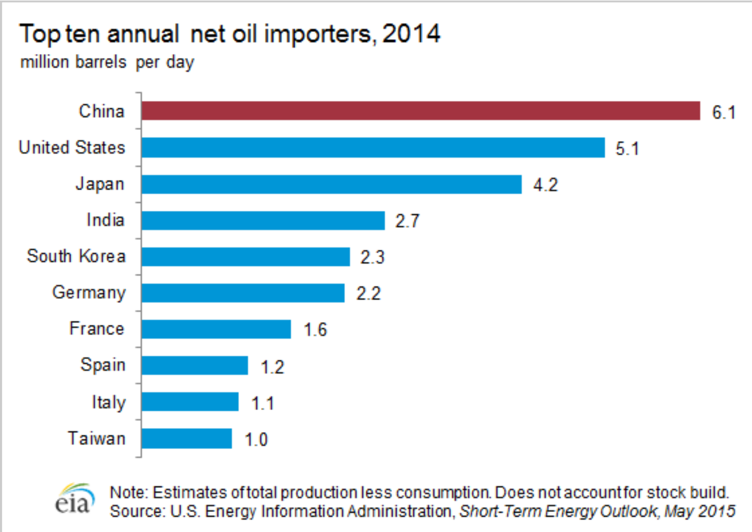
Petroleum and other liquids

China is the world's second-largest consumer of oil and moved from second-largest net importer of oil to the largest in 2014.

According to the *Oil & Gas Journal* (OGJ), released in January 2015, China holds 24.6 billion barrels of proved oil reserves, up almost 0.3 billion barrels from the 2014 level and the highest in the Asia-Pacific region (excluding Russia). China's total petroleum and other production, the fourth-largest in the world, has risen about 50% over the past two decades and serves only its domestic market. However, the production growth has not kept pace with demand growth during this period. In 2014, China produced nearly 4.6 million barrels per day (bbl/d) of petroleum and other liquids, of which 92% was crude oil and the remainder was non-refining liquids and refining gain. EIA forecasts China's oil production will increase slightly to higher than 4.6 million bbl/d by the end of 2016. In the medium and long term, EIA predicts China's oil production will grow incrementally to 5.1 million bbl/d by 2020, 5.5 million bbl/d by 2030, and 5.7 million bbl/d by 2040, based on the *International Energy Outlook 2014* (IEO2014). Long-term growth will require continued success of enhancing recovery at mature crude oil fields, greater investment to access more technically challenging plays such as shale oil, tight oil, and deepwater fields, and growth in non-petroleum liquids such as gas-to-liquids, coal-to-liquids, and biofuels.

China's annual growth in oil consumption has eased after a recent high of 11% in 2010, reflecting the effects of the most recent global financial and economic downturn as well as China's policies to reduce excessive investment and capacity overbuilding. Despite the slower growth, the country still accounted for more than one-third of global oil demand growth in 2014, according to EIA estimates. China consumed an estimated 10.7 million bbl/d of oil in 2014, up 370,000 bbl/d, or almost 4%, from 2013. Notably, China became the largest global net importer of oil in the first quarter of 2014, surpassing the United States, and the country's average net total oil imports reached 6.1 million bbl/d in 2014. Significant U.S. oil production from shale oil plays and rapid Chinese oil demand growth occurring simultaneously over the past few years pushed China ahead of the United States as the largest importer. China's oil demand growth depends on several factors, such as domestic economic growth and trade, transportation sector shifts, refining capabilities, and inventory builds. EIA forecasts that China's oil consumption will continue growing through 2016 at a moderate pace to approximately 11.3 million bbl/d. China's oil consumption growth is forecast in IEO2014 to rise by about 2.6% annually through 2040, reaching 13.1 million bbl/d in 2020, 16.9 million bbl/d in 2030, and 20.0 million bbl/d in 2040. EIA forecasts that China's oil consumption will exceed that of the United States by 2034.

China's demand growth for oil products has decelerated following a growth spike in 2010. Diesel (gasoil) is a key driver of China's oil products demand and accounted for an estimated 34% of total oil products demand in 2014. Diesel demand declined on an absolute level in 2014 for the first time in two decades, as a result of several factors—slower economic growth, decreased production from the coal and mining sectors that transport products via rail and trucks, greater efficiency in heavy-duty vehicles, and increased use of natural gas-fired vehicles in recent years. Gasoline, the second-largest consumed petroleum fuel in China with an estimated 23% share in 2014, is still experiencing robust demand growth as a result of high light-duty car sales.[9] China's middle class has expanded in the past decade, giving rise to high car sales. Future gasoline consumption will depend on the pace of economic development and income growth, fuel efficiency rates, and government regulations on passenger vehicle use in certain congested urban areas. Liquefied petroleum gas continues to experience some growth from the petrochemical industry, while fuel oil demand has weakened considerably.



Sector organization

China's national oil companies dominate the oil and natural gas upstream and downstream sectors, although the government has granted international oil companies more access to technically challenging onshore and deepwater offshore fields. China revised its oil price reform legislation in 2013 to further reflect international oil prices in the country's domestic demand.

The Chinese government's energy policies are dominated by the country's growing demand for oil and its reliance on oil imports. The National Development and Reform Commission (NDRC), a department of China's State Council, is the primary policymaking, planning, and regulatory authority of the energy sector, while other ministries such as the Ministry of Commerce, the Ministry of Land and Resources, the Ministry of Environmental Protection, and the State Oceanic Administration oversee various components of the country's oil policy. The government launched the National Energy Administration (NEA) in 2008 to act as the key energy regulator. The NEA, linked with the NDRC, is charged with approving new energy projects in China, setting domestic wholesale energy prices, and implementing the central government's energy policies, among other duties.[10] In January 2010, the government formed a National Energy Commission with the purpose of consolidating energy policies among the various agencies under the State Council and assessing major energy issues. Reforms under the new government leadership include consolidating and streamlining ministries and expanding the NEA's purview.[11]

National oil companies and others

China's national oil companies (NOCs) wield a significant amount of influence in China's oil sector. In the 1980s, China established three major NOCs—China National Petroleum Corporation (CNPC), the China Petroleum and Chemical Corporation (Sinopec), and China National Offshore Oil Corporation (CNOOC)—to serve in various areas of the oil sector. CNPC was put in charge of most of the country's onshore upstream assets, and Sinopec was given responsibility for the downstream activities such as refining, distribution, and petrochemicals. China gave CNOOC responsibility to explore and develop oil and gas assets in the offshore areas of China. In the late 1990s, the Chinese government reorganized most state-owned oil and gas assets and created separate operating companies or publicly-listed arms of each of the NOCs. These separate companies are majority-owned by each of the NOC holding companies. Additionally, in 1998, the government restructured CNPC and Sinopec into two vertically integrated firms that own both upstream and downstream assets, with CNPC taking some downstream assets and

Sinopec acquiring some fields for exploration and production (E&P). CNPC is the leading upstream player in China and, along with its publicly listed arm, PetroChina, accounts for an estimated 54% and 77% of China's crude oil and natural gas output, respectively, according to FACTS Global Energy (FGE).[12] CNPC's current strategy is to integrate its business sectors and capture more downstream market share. Sinopec seeks to acquire more upstream assets to capture more value from oil and gas production and diversify its revenue sources.

CNOOC, which is responsible for offshore oil and gas E&P, has seen its role expand as a result of growing attention to offshore zones and overseas assets. Also, the company has proven to be a growing competitor to CNPC and Sinopec by not only increasing its E&P expenditures in the South China Sea, but also by extending its reach into the downstream sector, particularly in the southern Guangdong Province.

Additional state-owned oil firms and private companies have emerged over the past several years. Sinochem Corporation, CITIC Group, and Yanchang Petroleum are state-owned firms that have expanded their presence in China's oil sector over the past decade, but these companies are still relatively small. Several independent and private companies own downstream oil infrastructure such as refineries, but their scope has remained limited by policies that have favored NOCs.

Onshore oil production in China is mostly limited to China's NOCs, but international oil companies (IOCs) have been granted greater access to offshore oil prospects and technically challenging onshore gas fields, mainly through production-sharing contracts (PSCs) and joint ventures (JVs). IOCs involved in offshore E&P working in China include: ConocoPhillips, Shell, Chevron, BP, BG, Husky, Anadarko, and Eni, among others. China's NOCs must hold the majority participating interest in a PSC and can become the operator once development costs have been recovered. IOCs offer their technical expertise in order to partner with a Chinese NOC and to gain entry into the Chinese markets.

Pricing reform

The Chinese government launched a fuel tax and reform of the domestic product pricing mechanism in 2009 in an effort to tie retail oil product prices more closely to international crude oil markets. This reform was designed to ensure better profit margins for refiners who must sell fuel at regulated prices and to reduce energy intensity that resulted from lower consumer prices and higher demand. The oil product pricing system adopted in 2009 allowed the NDRC to adjust retail prices when the moving average of imported crude prices fluctuated outside a 4% range around the established price within 22 consecutive working days for diesel and gasoline.

Despite the price reform, international crude oil prices increased at a faster rate than revisions made by the NDRC to retail fuel prices, causing refiners to incur losses on their downstream businesses and increase their fuel product exports. To promote greater market transparency and global changes, the NDRC revised the pricing regime in March 2013 by shortening the retail fuel price adjustment period to every 10 working days when prices automatically adjust to international crude price fluctuations greater than 50 yuan per metric ton (about $1.10/barrel). However, the NDRC did not identify the slate of crude oil types that it uses for price determination. When international oil prices began falling in the middle of 2014, the NDRC approved 12 downward price changes. When benchmark crude oil prices recovered slightly at the beginning of 2015, the NDRC reversed course by raising the retail prices twice.[13]

In 2011, China installed an ad valorem resource tax of 5% on all oil and gas production, including unconventional resources output, in an attempt to increase revenues for local and regional governments and to encourage more-efficient hydrocarbon production. The resource tax was raised to 6% in late 2014, although the tax rate was lower for projects using certain enhanced oil recovery (EOR) techniques or containing high sulfur or heavy oil.[14] China raised the threshold of its windfall resource tax from $55/bbl to $65/bbl to not deter investment in oil and gas investment after international oil prices fell to half of their previous level in late 2014.

Exploration and production

China's largest oil fields are mature, and production has peaked, leading companies to invest in techniques to sustain oil flows at the mature fields, while also focusing on developing largely untapped reserves in the western interior provinces and offshore fields.

After bolstering domestic oil output in 2010, China experienced more moderate oil production growth. China boosted its domestic oil output by more than 7% in 2010, after incremental growth in the previous two decades. Petroleum and total liquids production in 2014 reached nearly 4.6 million bbl/d, 50% higher than the level two decades ago. Most of this production is from crude oil (about 92%), and the remaining output is from coal-to-liquids, biofuels, and refinery processing gains. Approximately 80% of Chinese current crude oil production capacity is located onshore, and 20% of crude oil production is from shallow offshore reserves as of 2014.[15] New offshore production, use of EOR in older onshore fields, and small discoveries in existing basins are the main contributors to incremental production increases. China's NOCs are investing a great deal in EOR techniques such as water injection, polymer flooding, and steam flooding, among others, to offset oil production declines from these mature, onshore fields. Recent E&P activity has focused on the offshore areas of Bohai Bay and the South China Sea (SCS), as well as onshore oil and natural gas fields in western and central interior provinces such as Xinjiang, Sichuan, Gansu, and Inner Mongolia.

China's recent energy policy aims to improve domestic production by developing new oil fields. Meeting this goal will likely require significant investment in deepwater and tight oil extraction, and the lower oil prices since the second half of 2014 could affect long-term expenditures of the NOCs. The recent low-price oil environment, after international crude oil prices plunged by about 50% since June 2014, when price levels had averaged more than $100/bbl for three years, has caused some uncertainty about the future levels of NOC investment in domestic production. Even though oil prices have rebounded slightly since January 2015, EIA does not expect them to return to levels of early 2014 in the next one to two years. CNOOC announced recently that it plans to lower its overall capital expenditure on domestic and overseas upstream developments by 26% to 35% of its 2014 spending.[16] Also, CNPC and Sinopec plan to reduce their capital spending by 10% and 12%, respectively, in 2015 as the companies' revenues have declined following the oil price fall. Sustained lower oil prices place a significant downward risk to China's oil production growth in the near term. However, China has a vested interest in developing its domestic oil and gas reserves using cost-effective practices to strengthen its energy security.

Most of China's largest oil fields are located in the northeast and north central regions of the country and represents the backbone of the country's domestic production. However, these fields are mature and prone to declining production. CNPC's Daqing field, located in the northeastern region, is one of China's oldest and most prolific fields, constituting 19% of China's overall crude oil production. In 2014, Daqing produced about 800,000 bbl/d of crude oil, according to FGE, and has maintained this level for the past decade after declining from a level of about 1 million bbl/d.[18] Sinopec's Shengli oil field near the Bohai Bay produced about 557,000 bbl/d of crude oil during 2014, making it China's second-largest oil-producing field. The use of EOR in these fields has been able to slow decline rates. However, Daqing, Shengli, and other mature fields have been heavily exploited since the 1960s, and their output is expected to decline within the next decade. CNPC, the operator of Daqing, reports that they will reduce the field's output to 640,000 bbl/d by 2020 as a result of limited reserves, high production costs, and lower international oil prices.[19]

CNPC's use of various EOR techniques on the Liaohe and Jilin fields in the Northeast, some of China's oldest onshore oil fields, has helped stem production declines in recent years. Liaohe, one of China's largest heavy oil fields, produced around 200,000 bbl/d in 2014. Because CNPC began using more advanced EOR methods such as steam flooding and polymer flooding on a large scale at Liaohe in 2009, the NOC has successfully sustained production at the field during the past few years. CNPC has used hydraulic fracturing and CO2 injection at the Jilin field to mitigate further declines in hydrocarbon output.

China's interior provinces, such as the Northwest's Xinjiang Uygur Autonomous Region (including the Junggar and Tarim basins) and central Ordos basin (particularly the Changqing field), have attained strong production growth in recent years through the use of improved drilling and advanced oil extraction techniques to unlock complex geological oil reserves. As China constructs more storage and processing infrastructure in this region, it is heavily investing in developing the surrounding oil and gas fields. Total 2014 production from the Junggar, Tarim, and other key basins in the Xinjiang area was estimated at about 400,000 bbl/d.[20] CNPC applied a new EOR technology to the ultra-heavy Fengcheng field in the Junggar basin and has been sustaining its production over the past few years.[21]

Output at Changqing, China's third-largest producing oil field, which is located in the north central Ordos basin, grew robustly over the past several years, averaging more than 12% annual growth between 2006 and 2013. However, the field's pace of production growth slowed substantially to just 3% in 2014 when output reached 500,000 bbl/d. CNPC uses water injection, steam flooding, and hydraulic fracturing to boost Changqing's production.

Offshore E&P activities, mostly driven by CNOOC, have focused on the Bohai Bay region in the Yellow Sea, the South China Sea (particularly the Pearl River Mouth Basin), and, to a lesser extent, the East China Sea. Most of these fields are small and mature faster than China's onshore fields, prompting CNOOC to explore deepwater plays and to use EOR techniques for its more mature fields.

The Bohai Bay Basin, located in northeastern China east of Beijing, is the oldest oil-producing offshore zone and holds the bulk of proved offshore reserves in China. However, production from shallow waters in the Bohai Bay has been flat over the past few years. CNPC initiated the first phase of the Jidong Nanpu field development in 2007, and hoped to bring 200,000 bbl/d of crude oil production on stream by 2012. However, since then, the company claimed the reserves and production levels were overstated, and further exploration and reserve additions in the field would be necessary to meet its goals.

CNOOC's production in the Bohai Bay was 404,000 bbl/d in 2014, or nearly two-thirds of the NOC's domestic oil production. Following an oil leak at China's largest offshore crude oil field (Penglai 19-3) in July 2011 and a disruption to the field's total output for more than a year, CNOOC and its partner, ConocoPhillips, resumed production of about 120,000 bbl/d when they received government approval in early 2013. Production from the Penglai project is processed at China's largest floating production, storage, and offloading (FPSO) vessel with an offloading capacity of 190,000 bbl/d. Further development phases of Penglai are underway. CNOOC made five oil and gas discoveries and brought online one field in Bohai Bay with a peak production of 35,000 bbl/d in 2014. The NOC added another 84,000 bbl/d from small fields in the first few months of 2015 and expects to add another 6,000 bbl/d in the second half of the year.[22]

Although the South China Sea (SCS) is known to be gas-rich, CNOOC has also discovered several small oil fields and is focusing on deepwater discoveries. In 2014, CNOOC's total oil production in the SCS was 222,000 bbl/d, a majority coming from the Pearl River Mouth Basin in the eastern SCS. CNOOC's significant discoveries in the Enping, Panyu, and Liuhua areas opened up further opportunities for exploration in the eastern SCS. In 2014, CNOOC commenced production from oil fields in the Panyu 10, Enping 24, and Lufeng 7 blocks of the eastern SCS and added 115,000 bbl/d of peak production in the next few years. The NOC anticipates two more oil projects from the western SCS to begin operation in 2015, augmenting offshore production by another 24,000 bbl/d.[23]

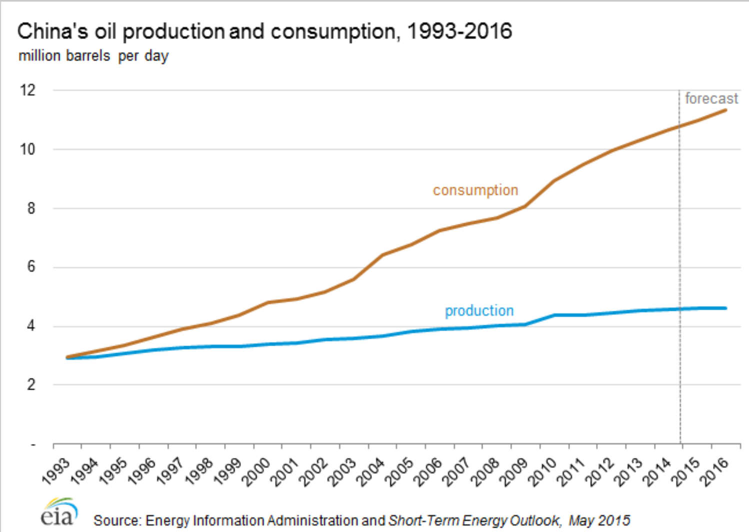
CNOOC has held annual licensing rounds since 2011, inviting foreign companies to jointly explore and develop offshore blocks in the Bohai Bay, SCS, and ECS. The latest tender was issued in 2014 and included 33 blocks, 12 of which are being carried over from the last bidding round in 2013.[24]

Territorial disputes

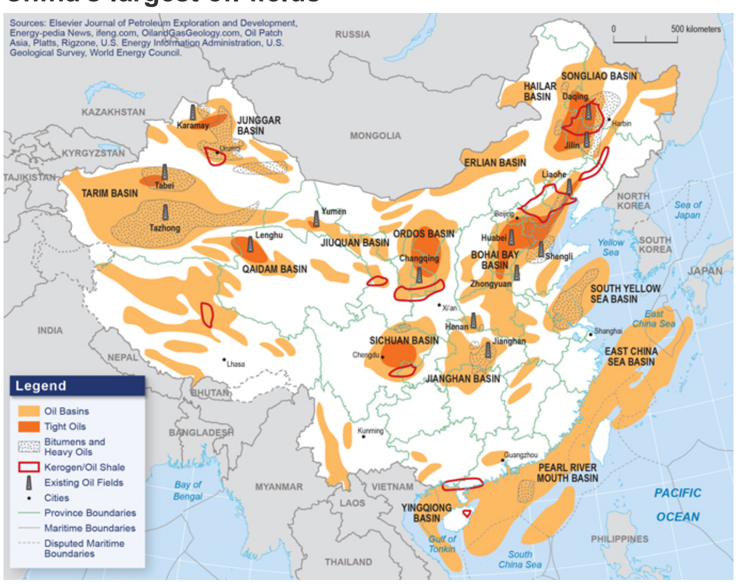
Territorial disputes in the East China Sea to date have limited large-scale development of oil and gas fields in the region, where China and Japan compete for territorial claims. The two countries have held negotiations to resolve the disputes. In June 2008, the two countries reached an agreement to develop jointly the Chunxiao/Shirakaba and Longjing/Asurao gas fields. However, in early 2009, the agreement unraveled when China asserted sovereignty over the fields. Since the agreement was signed, the countries have continued unilateral actions in attempts to develop the gas fields. Tensions escalated with territorial claims by Japan in 2012 over the Senkaku/Diaoyu Islands, China's installation of a production platform, CNOOC's proposal to develop several gas fields in the contested area in 2013, and China's claim to the air space above the islands in 2013. The two sides held talks at the end of 2014 to defuse some of the tension and improve relations over the territorial claims.[25]

Continued territorial disagreements by countries bordering the South China Sea, including ownership of the Spratly and Paracel Islands, have hindered efforts for joint exploration of hydrocarbon resources in the area. ASEAN members signed the Declaration of Conduct in 2002 that encourages countries to use restraint and cooperate in the South China Sea, but no regulations were established. China stakes claims to the SCS using a "nine-dash line" to determine each country's maritime borders and resources. Increasing appetites for oil and natural gas have exacerbated tensions, particularly between China and Vietnam and between China and the Philippines, as hydrocarbon development has attracted interest in deepwater areas. China has increased its naval activity in the contested areas, and CNOOC's June 2012 tender for nine offshore blocks in the disputed area overlaps several fields located within Vietnam's 200-nautical mile exclusive economic zone. China placed an oil rig in disputed waters near the Paracel islands for two months in 2014 and claimed the purpose was to explore for oil and gas in the area.[26] This move caused serious clashes with

Vietnamese vessels and has increased tensions within the region. China's current policy is to forge JV partnerships with the other SCS countries to explore and develop untapped hydrocarbon resources in the sea. More details covering the disputes in these two regions can be found in EIA's East China Sea and South China Sea regional briefs.



China's largest oil fields



Source: Carnegie Endowment for International Peace (Deborah Gordon, Yevgen Sautin, and Wang Tao), "China's Oil Future", May 6, 2014.

Overseas acquisitions

China's national oil companies have rapidly expanded their purchases of international oil and natural gas assets since 2008 through direct acquisitions of equity and financial loans in exchange for oil supplies in order to secure more oil and gas supplies, make long-term commercial investments, and gain technical expertise in more challenging oil and natural gas plays.

China's increasing dependence on oil imports, the need for Chinese companies to develop technical expertise for their more challenging resources, and attempts to capture value upstream are key factors driving Chinese NOCs to invest in international projects and form strategic commercial partnerships with IOCs. Since 2008, the NOCs have purchased assets in the Middle East, North America, Latin America, Africa, and Asia and invested an estimated $73 billion in overseas oil and gas assets between 2011 and 2013, according to the International Energy Agency (IEA). Most of China's recent direct acquisitions were channeled to deepwater oil plays off the coast of West Africa and Brazil, natural gas and coalbed methane opportunities in Australia, and oil sands and shale gas projects in North America.

China's oil production from its overseas equity shares and acquisitions grew significantly over the past several years, from 1.36 million bbl/d in 2010 to an estimated 2.1 million bbl/d in 2013, according to the IEA. CNPC holds the most equity production and investment overseas of all the NOCs, although Sinopec, CNOOC, and other smaller NOCs and private companies have rapidly expanded their overseas investment profiles over the past five years. Chinese companies are participating in upstream activities in 42 countries, and half of the overseas oil production stems from the Middle East and Africa. Iraq is a key country where all three of the NOCs have invested in several large fields where they expect production to increase. About 26% of China's overseas oil production in 2013 was in Iraq.[27] Kazakhstan, Sudan, and South Sudan are other countries that have contributed to sizeable portions of China's overseas production.

In the past few years, China has diversified its overseas upstream acquisitions to include new oil formations in Brazil and North America. Not only do these assets provide commercial opportunities, they allow the NOCs to gain technical expertise in challenging and unconventional plays. Although CNOOC contributed just small amounts to China's overseas hydrocarbon production for several years, the NOC has swiftly increased oil and gas purchases since 2010 in an attempt to gain technical expertise and acreage in shale oil, shale gas, and coalbed methane and deepwater hydrocarbon resources. Following approval from Canada, CNOOC purchased the Canadian oil company Nexen for $15.1 billion (plus $2.8 billion in Nexen's net debt) in 2013. This deal became China's largest overseas acquisition. CNPC, Sinopec, and Sinochem have purchased stakes in producing fields in Canada, the United States, and Brazil as well.

Chinese NOCs have also invested in overseas shale gas and tight gas formations to improve their technical capacities for developing these resources domestically and to secure gas supplies. As China rapidly expands its imports of liquefied natural gas (LNG), the NOCs are seeking supply contracts by purchasing stakes in the upstream developments and liquefaction terminals in the Asia-Pacific region, Canada, and the United States.

By the end of 2013, Chinese NOCs had secured bilateral oil-for-loan deals with several countries, amounting to almost $150 billion.[28] China provided loans to countries that need capital to extract energy reserves and build energy infrastructure in exchange for oil and gas imports at established prices. China extended oil-for-loan deals with Russia, Kazakhstan, Venezuela, Brazil, Ecuador, Bolivia, Angola, and Ghana and has had a gas-for-loan agreement with Turkmenistan over the past decade. Venezuela and China signed several deals for more than $45 billion in exchange for 600,000 bbl/d of crude oil and products. Based on China's trade data, Venezuela falls short of this amount, but the country's crude oil exports to China have ramped up markedly from four years ago and were 276,000 bbl/d in 2014. The recent low oil price environment is affecting Venezuela's upstream development and export capacity in the near term, and China provided another $5 million in 2015 for oil investment.[29] Several oil and gas deals have been signed with Russia in the past few years, including two loan-for-oil deals amounting to $50 million, signaling China's move to diversify its energy supply. Each of the deals includes 300,000 bbl/d of oil transported through the ESPO pipeline from Russia to China. CNPC and Russia's Rosneft formed a JV, where CNPC holds a 49% stake, to develop Russia's East Siberian oil fields, which are expected to help meet the export requirements of the deals.[30] These agreements signal the growing energy ties between the neighboring countries and China's interest in gaining more access to Russian oil.

Crude oil imports

Substantial oil demand growth and geopolitical uncertainties have led China to import greater volumes of crude oil from a wide range of sources.

As China's oil demand continues to outstrip production at home and the country continues building its strategic petroleum reserves, oil imports have increased dramatically over the past decade, reaching record highs set in 2014. To ensure adequate oil supply and mitigate geopolitical uncertainties, China has diversified its sources of crude oil imports in recent years. China imported nearly 6.2 million bbl/d of crude oil on average in 2014, rising 9% from 5.6 million bbl/d in 2013, according to China's customs data and FGE.[31] China's crude oil imports continued to remain high in the first few months of 2015 and climbed to a record-high level of 7.4 million bbl/d in April 2015.

Total net oil imports, driven primarily by crude oil imports, now outweigh domestic supply, and oil import dependency has risen from 30% in 2000 to about 57% in 2014 by EIA estimates. The government's current Five-Year Plan targets oil imports reaching no more than 61% of its demand by the end of 2015.[32] China's dependence on crude oil imports in the longer term will be determined by the sustainability and growth of domestic oil production, the rate of oil consumption growth as the government aims to create more sustainable economic growth, the speed of strategic and commercial stock fill, the fuel efficiency gains in transportation, and any substitution of fuels such as natural gas for oil.

The Middle East remains the largest source of China's crude oil imports, although African countries, particularly Angola, began contributing more to China's imports in the past decade. As part of China's energy supply security policy, the country's NOCs are attempting to diversify supply sources in various regions through overseas investments in upstream oil projects and long-term contracts. In 2014, the Middle East supplied China with 3.2 million bbl/d (52%). Other regions that export oil to China include Africa with 1.4 million bbl/d (22%), the Americas with 667,000 bbl/d (11%), Russia and the former Soviet Union with 778,000 bbl/d (13%), the Asia-Pacific region with 127,000 bbl/d (2%), and 27,300 bbl/d (<1%) from other countries. Saudi Arabia and Angola remain China's two largest sources of oil imports, and together they account for 29% of China's total crude oil imports.[33]

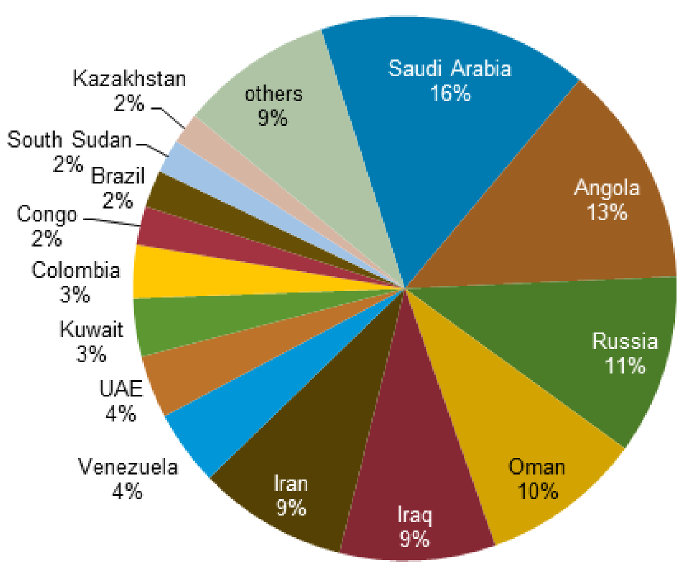
Global oil supply disruptions in recent years have shifted China's crude oil supply portfolio and forced the country to diversify its sources. Sudan and South Sudan became significant oil exporters to China until production was shut in at the beginning of 2012, following political conflicts between the two African nations over their oil resources. Exports from Sudan and South Sudan to China dropped from 260,000 bbl/d in 2011 to zero by April 2012. As production in the two African countries returned, China resumed a reduced level of imports, reaching 164,000 bbl/d in 2014. The ensuing shut-in of some of Libya's oil production since political uprisings began in 2011 has also affected oil exports to China.

Despite some Libyan exports that were brought back online in 2012, the political situation has deteriorated overall, and oil exports to China fell to just 19,000 bbl/d in 2014.

Historically, Iran was China's third-largest source of crude imports until 2012, when Russia surpassed it. Following U.S. and European sanctions on Iranian crude oil sales resulting from disagreements on Iran's nuclear program, China reduced its average annual oil import levels from Iran to maintain diplomatic ties with the United States and Europe. In 2012, China imported 439,000 bbl/d from Iran, or 20% less crude oil, from a high of 555,000 bbl/d in 2011. Iran constituted 8% of China's crude oil imports in 2012 and 2013 compared to 11% in 2011. Negotiations between Iran and six countries, including the United States and China, at the end of 2013 allowed Chinese buyers to raise Iranian imports back to levels before the sanctions took effect. Future crude import levels from Iran hinge on the final outcome of the nuclear agreement that was forged in April 2015 and how quickly oil-related sanctions can be lifted. Even if production resumes to pre-disruption levels from these countries, most analysts expect that China will continue to diversify import sources to reduce geopolitical risks and oil supply uncertainties.

China replaced the share of oil lost from Iran, Sudan and South Sudan, and Libya with imports from other Middle Eastern countries (United Arab Emirates, Oman, and Iraq), Angola, Venezuela, and Russia. China and Russia have signed deals for Russia to send China up to 800,000 bbl/d of crude oil by 2018, mostly by pipeline. Currently, Russia sends oil to China via pipeline, ship, and rail, primarily from Russia's fields in East Siberia.[34] To help meet its contract obligations to China, Russia holds a swap deal with Kazakhstan in 2013 and exports oil from its western Siberian fields through links to the currently underutilized Kazakhstan-to-China pipeline.[35] China has significantly increased imports from Iraq, although future import growth is likely to depend on the pace of infrastructure development and the political situation in Iraq.

China's crude oil imports by source, 2014



Sources: FACTS Global Energy, Global Trade Information Services, Inc.

Pipeline connections

China is improving its domestic oil pipeline network to integrate its oil supply and demand centers and to *diversify its oil import sources through pipeline links with Kazakhstan, Russia, and Myanmar.*

China has actively sought to improve the integration of the country's domestic oil pipeline network, as well as to establish international oil pipeline connections with neighboring countries to diversify oil import routes. According to CNPC, China had about 15,657 miles of total crude oil pipelines (70% managed by CNPC and the remaining 30% by other NOCs) and 12,605 miles of oil products pipelines in its domestic network at the end of 2013.[36] The bulk of China's oil pipeline infrastructure serves the more-industrialized coastal markets and the northeastern region. However, several long-distance pipeline links have been built or are under construction to deliver oil supplies from the northwestern region or from downstream refining centers to more-remote markets in the central and southwestern regions.

China inaugurated its first transnational oil pipeline in 2006, when it began receiving Kazakh and Russian oil from a pipeline originating in Kazakhstan. The pipeline, developed by a joint venture between CNPC and Kazakhstan's KazMunayGas (KMG) and financed by Chinese loans, transports oil from the oilfields in western and central Kazakhstan to China. The pipeline, which has been developed in stages, connects Atyrau in western Kazakhstan on the Caspian Sea with Alashankou on the Chinese border in Xinjiang. The pipeline's initial capacity was 200,000 bbl/d, and an expansion in 2013 along the route from central Kazakhstan to China doubled the capacity to 400,000 bbl/d on the Atasu-to-Alashankou section. Further infrastructure expansion and export capabilities are contingent on the development of Kazakhstan's Kashagan field as well as domestic requirements on the Kazakh side.[37]

Russia's new East Siberian oil fields have become another source for Chinese crude oil imports. Russian state-owned oil giant Transneft constructed the Eastern Siberia-Pacific Ocean (ESPO) Pipeline, extending 3,000 miles from the Russian city of Taishet to the Pacific Coast in two stages. The first stage of the project included the construction of a 740,000-bbl/d pipeline from Taishet to Skovorodino in Russia. CNPC also built a 597-mile pipeline linking the spur with the Daqing oil field in the Northeast. The pipeline spur to China became operational in January 2011, and delivers up to 300,000 bbl/d of Russian oil to the Chinese border under an original 20-year supply contract between the two countries. The second stage of ESPO came online at the end of 2012 and delivers oil to the Russian Pacific port of Kozmino. This port provides Russia the option to send more crude oil to China via a sea route. Russia anticipates expanding the ESPO transmission capacity to Skovorodino to 1.6 million bbl/d by 2020 and augmenting contracted supply to China through this route.[38]

China launched an oil import pipeline with a capacity of 440,000 bbl/d from Myanmar in January 2015.[39] Myanmar is not a significant oil producer, so the pipeline is envisioned as an alternative transport route for crude oil from the Middle East that would bypass the potential choke point of the Strait of Malacca, which approximately 80% of China's oil imports traverse based on crude oil import sources and routes. CNPC plans to send crude oil from the pipeline to serve the Yunnan/Anning refinery that is slated to start operations in 2016 and to the Chongqing refinery that could begin operations in 2017. In the meantime, China plans to store any oil imports from the pipeline in excess of local demand.

Refining

As part of its goal to diversify crude oil import sources and meet oil product demand, China has steadily *augmented its refining capacity, which exceeded 14 million bbl/d by 2015. However, weaker Chinese oil demand growth in recent years created excess refining capacity, and many refinery projects are experiencing delays in construction.*

China has steadily expanded its oil refining capacity to meet its strong demand growth and to process a wider range of crude oil types. The country now ranks behind only the United States and the European Union in the amount of refining capacity. China's installed crude refining capacity reached nearly 14.2 million bbl/d by 2015, about 680,000 bbl/d higher than in 2013, according to FGE.[40] Two new greenfield terminals started operations in the first half of 2014—CNPC's Pengzhou and Sinochem's Quanzhou, which contributed to most of the capacity additions that year. However, no new terminals are expected to come online until the latter half of 2016, and only a few expansion projects are expected to add incremental capacity of less than 200,000 bbl/d in 2015. Some of the new refineries are designed to accept all grades of crude oil, making Chinese refineries a strong regional competitor. The country intends to meet its domestic demand, which has grown rapidly in the past several years, but also to export petroleum products within the region.

Refinery utilization rates have declined to less than 75% in the past year as Chinese companies continued to build refining capacity against a backdrop of slower oil demand growth in China and around the world.[41] The government expanded refining companies' product export quotas in 2014 and 2015 because domestic demand growth had slackened since 2012. The NDRC claims that incremental refining capacity is expected to be 3.4 million bbl/d between 2016 and 2020. However, industry analysts anticipate China would add only 1.5 million bbl/d of net capacity between 2015 and 2020, as a result of several project delays and overcapacity during the past two years. Projects such as CNOOC's Huizhou expansion, CNPC's Huabei, Anning, and Jieyang, and Sinopec's Zhangjiang have all been pushed back by one to two years from their originally planned start dates.[42]

Recent heavy pollution in certain areas of China prompted the NDRC to adopt stricter petroleum product specifications that are intended to lower sulfur emissions from gasoline and diesel use. The agency requires refineries to implement the equivalent of Euro IV standards for transportation fuels nationwide in 2015 and Euro V standards by January 2017, a year ahead of the prior schedule.[43] Shanghai and Beijing are already supplying only fuels that meet Euro V standards. Sinopec and CNPC are investing in refinery upgrades to meet these emissions standards, but the small independent refineries are facing economic challenges of additional cost.

China's notable refinery projects and expansions

Company owner	Location	Capacity	Start date	Notes
Sinopec	Caofeidian/Tianjin	240,000	2020+	Construction; Received NDRC approval January 2015; Plans to process crude oil from Saudi Arabia
Sinopec	Guangdong/Zhanjiang	300,000	2017	Construction; Developing with Kuwait Petroleum (30%) and Total (20%)
Sinopec	Hainan	100,000	2020+	Environmental approval received

				February 2013
Sinopec	Luoyang	160,000	2020	Expansion project
CNPC/PetroChina	Huabei	100,000	2017	Upgrading; Construction
CNPC/PetroChina	Anning/Yunnan	200,000	2016	Construction; Plans to process oil from Saudi Arabia and Kuwait via the crude oil pipeline from Myanmar; JV with Saudi Aramco (39%) and Yuntianhua Group (10%)
CNPC/PetroChina	Guangdong/Jieyang	400,000	2018	Construction; JV with PDVSA (40%)
CNPC/PetroChina	Tianjin	320,000	2020	Construction agreement signed between partners; JV with Rosneft (49%)
CNOOC	Ningbo Daxie/Zhejiang	140,000	2015	Construction; Expansion to 300,000 bbl/d
CNOOC	Huizhou Phase 2	200,000	2016	Construction; Expansion

Sources: U.S. Energy Information Administration based on FACTS Global Energy,[44] International Energy Agency,[45] Reuters, company information.

The oil refining sector has undergone modernization and consolidation in recent years, shutting down dozens of smaller, independent refineries (commonly known as teapots). These smaller, independent refineries account for more than 20% of China's total refinery capacity.[46] The NDRC issued guidelines in 2011 to eliminate refineries smaller than 40,000 bbl/d by the end of 2013 in an effort to encourage economies of scale and efficiency measures. Several of these local refineries, mostly located in the northeastern Shandong province, expanded their capacity or consolidated with larger firms to avoid closing, and some continued to operate. Recent refining capacity overruns, unfavorable economics, higher oil product consumption taxes on fuel oil at the end of 2014, and restrictions to crude oil imports imposed on independent refiners have pressed the local government in Shandong to streamline capacity of these small facilities. In addition to placing a moratorium on new projects as of 2014, the Shandong government added other reforms including a refining capacity ceiling of 90,000 bbl/d by 2017.[47] The NDRC announced a policy in early 2015 allowing local refiners to gain greater access to imported crude oil if they reduce excess capacity and remove facilities with less than 40,000 bbl/d in capacity, modernize or remove antiquated facilities, and build oil storage facilities.[48]

Domestic price regulations for petroleum products resulted in revenue losses for Chinese refiners, particularly small ones, in the past few years when international oil prices were high. This price differential squeezed refineries' profit margins, leading to reduced processing rates at some independent refineries. The oil price reforms recently implemented by the NDRC have reduced some of these revenue losses and allowed refiners to be more responsive to domestic demand and global markets.

Although China remains an overall net oil product importer, the country became a net diesel fuel exporter in mid-2012, mostly to other Asian countries, as growth in domestic oil product demand slowed. The NDRC issues export quotas on oil products to NOCs to ensure that domestic demand for major oil products is met, with the possibility to extend the quotas if supply exceeds demand. The government set export quotas at 73 million barrels of oil products in 2015, up from 60 million barrels in 2014.[49] In 2014, China imported approximately 600,000 bbl/d and exported about 586,000 bbl/d of petroleum products.[50] As refining capacity expands, albeit at a much slower pace during the next two years, exports of products, particularly gasoline, jet fuel, and diesel, are likely to grow. Meanwhile, imports of liquefied petroleum gas and naphtha have increased over the past few years.

NOC participation

Sinopec and CNPC/PetroChina are the two dominant players in China's oil refining sector, respectively accounting for 41% and 31% of the country's capacity in 2014, according to FGE.[51] Sinopec, which operated 5.6 million bbl/d of total oil processing capacity in China in 2014 and holds a significant refining presence in the coastal and southern areas of China, is the largest oil refiner in the world. Sinopec relies heavily on imported crude oil for its refineries, and most of the NOC's refineries are configured to handle crude oil higher in sulfur and acidity.

The other NOCs are now building refineries and pipelines to compete with Sinopec's strong presence in China's downstream markets. CNPC expanded its downstream presence in southern China, and it started commercial operations of its 200,000-bbl/d Pengzhou refinery in Sichuan Province at the beginning of 2014. CNOOC entered the downstream sector by commissioning the company's first refinery, the 240,000 bbl/d Huizhou plant in 2009. The NOC anticipates expanding this refinery by 200,000 bbl/d in 2015. Sinochem commissioned its first major refinery, Quanzhou, at the end of 2013.

National oil companies from Kuwait, Saudi Arabia, Russia, Qatar, and Venezuela have also entered into joint ventures with Chinese companies to build integrated refinery and petrochemical projects and to gain a foothold in China's downstream oil sector.

Chinese companies have ventured into overseas refining opportunities. In addition to its strong domestic presence, Sinopec is gradually investing in refining assets overseas, and the company purchased a 37.5% stake in Saudi Arabia's 400,000 bbl/d Yanbu refinery and began processing heavy crude oils in 2015. Sinopec has entered into joint venture partnerships to develop refinery projects in Africa and Latin America and invested in oil storage projects abroad. CNPC branched out to acquire refinery stakes in other countries to move downstream and secure more global trading and arbitrage opportunities. The company's purchases of refinery shares in Singapore and Japan a few years ago are cases where CNPC was looking for a share in the region's refining opportunities. Also, CNPC has invested in refineries and pipelines in African countries in exchange for exploration and production rights.

Strategic petroleum reserves and crude oil storage

China's plan to construct crude oil storage through both state-owned strategic petroleum reserves and commercial crude oil reserves reflects its need to secure energy in light of its growing reliance on oil imports. The government intends to build strategic crude oil storage capacity of at least 500 million barrels by 2020.

In response to China's need for energy security and its growing reliance on oil imports, the country is in the process of developing significant storage capacity to buffer geopolitical issues involving global oil supply. In China's 10th Five-Year Plan (2001-2005), Chinese officials decided to establish a government-administered strategic petroleum reserve program (SPR) to help shield the country from potential oil supply disruptions. The plan involves three phases and calls for China to construct facilities that can hold 500 million barrels of crude oil by 2020. Currently, China has built between 141 and 180 million barrels of total storage capacity for the SPR, and several sites are under construction. SPR sites are operated almost exclusively by the major Chinese NOCs, although the Chinese government recently encouraged private investment in crude oil storage. Phase 1, completed in 2009, has a total storage capacity of 103 million barrels at four sites. China reported that this first phase held 91 million barrels at the end of 2014. Phase 2 is expected to add about 170 million barrels to the SPR capacity by 2020, and another 232 million barrels are proposed for phase three.[52] Industry sources report that at least two Phase 2 sites, which add 39 million barrels to the capacity, were completed in 2011, and possibly two more came online in 2014.[53] Some of the Phase 2 sites are located inland in western and central China, while the others are scattered along the eastern and southern coasts, allowing China to fill the facilities from various sources. Once these sites are commissioned, there is an incentive for China to continue building crude oil inventories to enhance the country's oil supplies. High levels of crude oil imports in 2014 could indicate that China was filling some of its SPR.

In addition to the strategic reserves of crude oil, China held around 350 million barrels of commercial crude oil storage capacity at the beginning of 2014.[54] The distinction between future strategic and commercial storage reserve capacity is not clearly defined, and there could be crossover between some of the facilities.

Stockpiling rates for strategic and commercial storage in China depend on factors such as supply security, crude oil prices, domestic demand, domestic policy goals, and the storage capacity build. The Chinese government reported the average Brent crude price was $58/barrel for purchasing oil in Phase 1.[55] However, prices in the past few years until mid-2014 have averaged more than $100/barrel, making purchases for storage more expensive. While China's official stocks are not disclosed on a regular or complete basis, commercial stocks have fluctuated over the past four years based on swings in crude oil imports and refining runs each month. One driving factor for additional stock build in the next several years is China's goal to hold at least 90 days' worth of net oil imports by 2020.

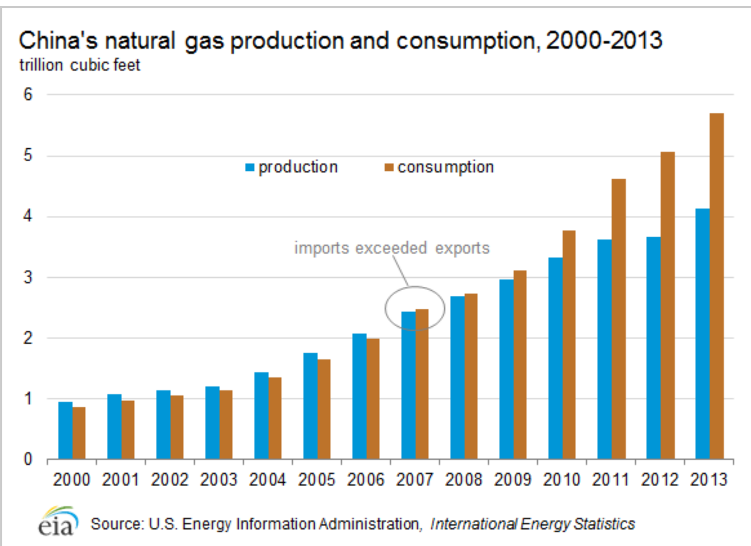
Natural gas

Although natural gas production and use is rapidly increasing in China, the fuel comprised only 5% of the country's total primary energy consumption in 2012. Heavy investments in upstream development and greater import opportunities are likely to underpin significant growth in China's natural gas sector.

China held 164 trillion cubic feet (Tcf) of proved natural gas reserves in January 2015, according to data released by OGJ, 9 Tcf higher than reserves estimated in 2014 and the largest in the Asia-Pacific region. China's natural gas production and demand have risen substantially in the past decade. China more than tripled natural gas production to 4.1 Tcf between 2003 and 2013. FGE estimates that natural gas output continued rising in 2014 to more than 4.4 Tcf. The government targets 6.5 Tcf of natural gas production by 2020 in line with its desire to use more natural gas to replace other hydrocarbons in the country's energy portfolio.[56]

The Chinese government anticipates boosting the share of natural gas as part of total energy consumption to at least 10% by 2020 to alleviate high levels of pollution resulting from the country's heavy coal use.[57] Consumption in 2013 rose to 5.7 Tcf, 12% greater than 2012, and the country imported about 1.8 Tcf of liquefied natural gas (LNG) and pipeline gas to fill the gap. Although the majority of gas consumption stems from industrial users (32% in 2013), the shares of gas consumption in the power and transportation sectors have been rising over the past decade.[58] To meet projected long-term demand increases, China is expected to continue importing natural gas in the form of LNG and from a number of new and proposed import pipelines from neighboring countries. It will also have to tap into its expanding domestic reserves and establish a wider domestic natural gas network and storage capacity.

China was traditionally a net gas exporter until 2007, when it became a net natural gas importer for the first time. Since then, gas imports have increased dramatically in tandem with rapidly developing pipeline and natural gas processing infrastructure. Natural gas imports, which met 32% of demand in 2013, have become an increasingly significant part of China's gas supply portfolio.



Sector organization

The NOCs lead the natural gas development of China. Similar to oil exploration and production, these companies partner with international companies to develop natural gas projects requiring more technical expertise. The shifting landscape of China's natural gas supply sources towards greater imports and the need to bolster investment were the factors leading the government to implement the recent price reforms and align domestic natural gas prices more closely to market-based rates.

As with oil, the natural gas sector is dominated by the three principal state-owned oil and gas companies: CNPC, Sinopec, and CNOOC. CNPC is the country's largest natural gas company in both the upstream and downstream sectors. CNPC accounts for roughly 77% of China's total natural gas production, according to FGE.[59] Sinopec operates the Puguang natural gas field in Sichuan Province, one of China's most promising upstream assets. CNOOC led the development of China's first three LNG import terminals at Guangdong, Fujian, and Shanghai and manages much of the country's offshore production. CNOOC typically uses PSC agreements with foreign companies wanting to jointly develop upstream offshore projects and has the right to acquire up to a 51% working interest in all offshore discoveries once the IOC recovers its development costs.[60]

China's rapidly growing natural gas demand over the past few years has opened up opportunities for independent Chinese energy companies to operate in the LNG space and in unconventional gas production. China's three NOCs own majority stakes in most of the existing and proposed terminals, although the swiftly changing LNG landscape is opening up opportunities for smaller local and private firms. Several local state-owned municipalities, gas distributors, and power developers own minority stakes in several existing LNG terminals, and two non-NOCs (Shenergy Group and JOVO Group) hold majority ownership in facilities. In 2013, JOVO Group became the first private Chinese company to own a majority stake in a regasification terminal, and the company signed a long-term contract with Malaysia's Petronas, marking the first private company to hold a long term LNG purchase agreement. The government initiated a new policy in early 2014 to allow access rights to third party companies for supplying natural gas to LNG terminals, providing more supply opportunities from firms involved along the entire LNG value chain, from the upstream gas procurement to the downstream distribution. Development of unconventional gas supply, primarily from coal-bed methane or shale gas, has attracted greater interest from private investment, and local and private Chinese companies are involved in owning and exploring these resources.

Natural gas pricing and reforms

China's natural gas prices, similar to retail oil prices, are regulated by the NDRC and have been kept below international market rates. China's nascent natural gas market has flourished in the past few years and has become more complex as relatively expensive gas imports began to compete with domestic production. In order to bolster investment in the natural gas sector, to create more transparency in the pricing system and responsiveness to market fluctuations, and to make domestic natural gas competitive with other fuels and imported gas, the NDRC implemented a new system linking gas prices more closely to higher international oil prices.

China launched a pilot program for natural gas price reform in the southern provinces of Guangdong and Guangxi at the end of 2011. Following this pilot phase, China rolled out the reforms on a nationwide basis for all customers, apart from the residential and fertilizer sectors, in July 2013 as a three-phase reform process. The new system links the natural gas prices at the citygate (delivery point from a gas transmission pipeline to a local distribution utility) to the price of imported fuel oil and liquefied petroleum gas. The linked natural gas price is discounted to some degree to encourage use of natural gas rather than coal. The pricing scheme covers natural gas from imported pipeline gas, most domestic onshore sources, and LNG imports sent through pipelines. Prices for shale gas, coalbed methane, and coal-to-gas, and LNG imports sold at the terminal for local distribution can be negotiated between the producer and the wholesale buyer and are not subject to regulation. The reform created two categories of prices, one for existing demand based on 2012 consumption (Tier 1) and incremental natural gas demand above 2012 levels (Tier 2). The NDRC raised the average price for all Tier 1 customers by about 15% for non residential consumers. Average citygate ceiling prices for the second tier were set about $3.7/MMBtu higher than the first-tier volumes.[61]

In September 2014, China ushered in the second phase of the reforms by increasing the prices for existing demand (Tier 1) by around 20%, while keeping the price caps for the incremental demand (Tier 2) the same.[62] At this time, China created market-based prices for all imported LNG, shale gas, coalbed methane, and coal-to-gas even for volumes transported through the long-distance pipeline network. This policy allows sellers to market the gas directly to buyers through independent sales agreements.

In the third phase, which took effect April 1, 2015, the government combined the prices of the two tiers into one price by lowering the price for incremental demand and raising the price for the existing customer base. This last phase effectively lowered the price of Tier 2 customers by about $1.90/MMBtu and slightly raised the price for Tier 1 customers by $0.17/MMBtu, resulting in a weighted average price of 2.51 yuan/cubic meter ($10.62/MMBtu). Overall, average regulated citygate prices increased by more than 36% between the time prior to the reforms in 2013 and the third phase in 2015, according to IHS Energy.[63] The NDRC plans to adjust this price ceiling every six months in line with the LPG and fuel oil prices. China also intends to create more market-based rates for residential customers by the end of 2015, but this directive has not been clearly defined yet.[64]

Exploration and production

China contains several natural gas-producing regions, including the western and central parts of the country as well as offshore basins. While eager to develop older natural gas fields, China's oil companies are exploring and developing frontier plays such as deepwater, shale gas, and gas derived from coal seams. The country's first deepwater field came online in 2014, and similar developments are under development.

China's primary onshore natural gas-producing regions are Sichuan Province in the Southwest (Sichuan Basin); the Xinjiang and Qinghai Provinces in the Northwest (Tarim, Junggar, and Qaidam Basins); and Shanxi Province in the North (Ordos Basin). China has delved into several offshore natural gas fields located in the Bohai Basin and the Panyu complex of the Pearl River Mouth Basin (South China Sea) and also is exploring more technically challenging areas such as deepwater, coalbed methane, and shale gas reserves with foreign companies.

Southwest

The Sichuan Basin is China's key natural gas-producing area in the southwestern region. The largest recent discoveries in this region are Sinopec's high-sulfur natural gas finds at the Yuanba and Puguang fields. Sinopec started commercial production at Puguang in 2010 and ramped up to its peak capacity of 350 Bcf in 2012. Sinopec anticipates the field will produce at this level for about two decades. The NOC anticipates the Yuanba field, which began operation in 2014, will produce 120 Bcf/y by 2016.[65]

Sichuan Province also holds five high-sulfur content (sour) gas fields in the Chuandongbei basin. In 2007, CNPC awarded a 30-year PSC to Chevron to bring the technically challenging fields online by 2010. Field development has encountered several delays, and initial production has been pushed back to 2015 at the earliest.[66] Chevron is building two sour natural gas processing plants with a combined production capacity of 204 Bcf/y.[67] CNPC also announced a major new discovery in 2014 and claims that the Anyue gas field holds nearly 11 Tcf of technically recoverable reserves.[68]

Northwest

Xinjiang Uygur Autonomous Region historically has been home to one of China's largest and most prolific gas-producing regions, with output of 980 Bcf in 2014. The Tarim Basin in

Xinjiang was the second-largest gas-producing basin in China in 2014, supplying 832 Bcf/y, or 19% of China's total production.[69] The basin's complex geological features make development costs relatively high. CNPC's two cross-country West-East Gas Pipelines, connecting Xinjiang to Shanghai, Beijing, and Guangdong, have greatly expanded the upstream potential for the Tarim Basin to supply markets in eastern China. The Tarim Basin's major fields—Kela-2, Dina-2, Yaha, and Yingmaili—are still undergoing exploration and development and are key sources supplying the West-East Pipelines.[70] Other new discoveries in the Northwest that have high gas supply potential are the Junggar Basin in Xinjiang Province and the Qaidam Basin in Qinghai Province.

Northeast

The Changqing oil and gas area in the Ordos basin is China's largest gas-producing area and houses the Sulige gas field. Development of this region is both geologically and technically challenging, and most of the reserves are tight gas (characterized by low permeability and low pressure and usually requiring hydraulic fracturing for commercial production). Partnering with IOCs Total and Shell Oil, CNPC is effectively using advanced drilling techniques and recovery methods to retrieve natural gas from projects in the South Sulige and Changbei fields. Changqing's production rose steadily over the past decade to 1,347 Bcf in 2014, and constituted 31% of China's total gas output.[71]

The Songliao basin holds the Daqing oil and gas field, which produced 124 Bcf in 2014.[72] Also, China began the process of reinjecting carbon dioxide to enhance recovery rates for the mature fields in this area. The Jilin oil field recently began using CO2 injection produced from the associated Changling gas field for enhanced recovery.

Offshore

Offshore zones have also received increasing attention for upstream natural gas developments in China, and CNOOC is the primary stakeholder of exploration rights. The NOC produced about 175 Bcf in 2014 in the South China Sea (SCS). The western South China Sea accounted for about 53% of CNOOC's domestic gas production, although the NOC sees great potential for development in the eastern South China Sea.[73] The western South China Sea is home to the Yacheng 13-1 field, China's largest offshore natural gas field and a primary source of energy for Hong Kong's power stations. However, production levels from the Yacheng 13-1 field and a few others are in decline, forcing CNOOC to explore and develop other nearby blocks and explore more deepwater areas to replace diminishing reserves. Other fields have entered operations since 2005 and offset some declines from Yacheng, and CNOOC's long-term development plans include exploration of deepwater fields in the Pearl River Mouth and Qiongdongnan Basins.

The eastern SCS is under intense exploration for natural gas. The NOC partnered with Husky Energy to develop China's first large-scale deepwater gas project at Liwan 3-1, which started production at its first field in early 2014. The project's second field came online at the end of 2014. CNOOC expects the Liwan gas project, which includes three fields and 4 to 6 Tcf of reserves, to ramp up production to 180 Bcf/y by 2018 and to be one of the company's largest new sources of incremental gas production in the next few years.[74] As development continues, other deepwater fields such as Panyu 34-1 will feed into the main processing platform at Liwan. CNOOC made two significant gas discoveries in the Qiongdongnan Basin, Lingshui 17-2 and Lingshui 25-1, and the company claims Lingshui 17-2 is one of China's largest offshore discoveries with proved reserves estimated to be 3.5 Tcf.[75] Other IOCs, namely Chevron, BG, BP, Anadarko, and Eni, signed PSCs for more deepwater hydrocarbon blocks in the SCS.

Coalbed methane, coal-to-gas, and shale gas

The coalbed methane (CBM), coal-to-gas (CTG) or synthetic natural gas (SNG), and shale gas industries in China are in early stages of development because of technical and water resource challenges, regulatory hurdles, transportation constraints, and competition with other fuels and conventional natural gas. However, China's potential wealth of these resources has spurred the government to seek foreign investors with technical expertise to exploit them.

Most of China's CBM volumes are from basins in the North and Northeast, the Sichuan basin in the Southwest, and the Junggar and Tarim basins in the West. FGE reported that CBM production in 2014 was an estimated 584 Bcf, up from about 475 Bcf in 2013, from both surface wells and coal mines. China's NEA set the most recent 2020 target for production at 1.4 Tcf of CBM, half from extraction of coal, and half from surface mining. Most of the CBM production is from coal mine extraction, which hinders higher utilization rates because some of the methane gas that seeps from the underground mines is vented. Current utilization rates are about 45%, and China intends to reduce the production waste and increase consumption of coalbed methane. Although CBM production is increasing, company developers face regulatory hurdles, technical challenges, lack of pipeline infrastructure from linking coal-mining areas to gas markets, high development costs, and competition with other forms of natural gas supply. At times, there are conflicting interests between governing bodies when dealing with mineral and land rights. The local governments hold rights to coal mines, whereas the central government has rights to natural gas and CBM. China's State Council issued a policy guideline in September 2013 encouraging investment in CBM exploration and development and more pipeline infrastructure through financial incentives and tax breaks to producers and reform of local price controls.[76]

China's first commercial CBM pipeline became operational in late 2009, linking the Qinshui Basin with the West-to-East pipeline. Several other pipelines, mostly in the Shanxi Province of north central China, have become operational, and several more are under construction. China also uses many small liquefaction plants and trucks to transport CBM to demand centers.

After 2012, China was rapidly approving CTG projects so that it could use its vast resources of coal to satisfy growing natural gas demand along the eastern and southern coastal areas. As a result of looser government regulations and more favorable economics for natural gas projects, Local power and coal companies and NOCs entered the market to develop several CTG projects. Although China's original CTG production target was 530 Bcf by 2015, the industry has experienced very slow progress. China produced only 75 Bcf in 2014 from its two operational CTG plants—Datang Group's plant located in the northern province of Inner Mongolia and Kingho Energy Group's plant in the northwestern Xinjiang province—that have a combined capacity of less than 100 Bcf/y.[77] However, these plants are running at low utilization rates as a result of technical problems and design issues. Three other projects are under construction, including Sinopec's Zhundong project, China's largest CTG project located in Xinjiang province. The plant is scheduled to come online in 2017 and connect with pipelines carrying the natural gas towards eastern China. So far, the NDRC has approved 15 large-scale CTG projects with a total capacity of more than 2,800 Bcf/y.[78]

Several more facilities are in the planning phase, but CTG projects face high capital costs required to develop the attendant infrastructure, require scarce water resources, and produce high levels of emissions. These factors could affect the potential construction of many of these projects. China's NEA is concerned that the industry does not overbuild with several small facilities, so they imposed a regulation that requires CTG plants to have a capacity of at least 70 Bcf/y to operate.[79]

Even though China's shale gas industry has vast potential for growth, it is currently in nascent stages, and developers and regulators are working through many challenges. Most of China's proved shale gas resources are in the Sichuan and Tarim basins in the southern and western regions and in the northern and northeastern basins. EIA estimates from its most recent report on shale oil and gas resources that China's technically recoverable shale gas reserves are 1,115 Tcf, the largest shale gas reserves in the world.[80] Shale gas production, mostly from Sinopec's Fuling block and CNPC's Changning-Weiyuan block in the Sichuan basin, grew by more than five times between 2013 and 2014 and reached 46 Bcf/y. Sinopec's recent success in developing its Fuling gas field is significantly boosting production levels, and the NOC reported that Fuling could ramp up output to 353 Bcf by 2017.[81] Despite this significant discovery, current shale gas production is falling short of the Ministry of Land Resources' original goal to produce 230 Bcf of shale gas by the end of 2015. As part of China's new energy targets, the government halved the original 2020 shale gas production target to about 1,060 Bcf, a more realistic goal based on the geological risks, lack of water needed for shale resource development, and lower-than-expected production rates. Even though there is great potential for shale gas development in China, greater investment in these technically challenging plays and attendant infrastructure is necessary as drilling costs remain high. Also, shale gas is competing against several other sources of natural gas, which may take precedence in the near term. Several industry analysts anticipate China's shale gas production will play a significant role in the natural gas supply slate after 2020.[82]

Although several small, local Chinese companies have entered China's shale gas industry, state-owned companies, primarily CNPC and Sinopec, own the vast majority of China's shale gas resources. These NOCs are partnering with several IOCs to gain necessary technical skills and investment for developing these geologically challenging resources. CNPC and Shell signed the first PSC for the Fushun-Yonghchuan block of shale gas in the Sichuan Basin in March 2012. Shell also has partnered with Sinopec and CNOOC on two other shale gas plays. Sinopec is working with Chevron and ConocoPhillips to explore shale gas resources in the Qiannan and Sichuan basins, respectively. Although the IOCs have drilled several wells so far, these projects are still in assessment stages. Chinese NOCs have also actively invested in shale oil and gas plays in North America to gain technical expertise in this arena.

China held its first shale gas licensing round in 2011 for four blocks in the Sichuan Basin and awarded the tenders to two Chinese companies: Sinopec and Henan Coal. Tendering is available not only to NOCs but also to private and local companies, and foreign investors may participate indirectly if they hold a PSC contract with a participating Chinese firm. The State Council released shale gas from the jurisdiction of the NOCs, allowing the MLR to open a larger second bidding round in mid-2012. The MLR awarded 19 blocks to 16 domestic companies, mostly to coal producers, power companies, and local energy firms. Since these companies have limited shale gas experience and the capital required for such projects, they may partner with China's larger state-owned companies or with foreign companies. China's third shale gas round was expected to launch in 2013 but continues to experience delays. The MLR is in the process of selecting blocks based on high quality and greater potential to attract investors.[83]

China's shale oil and gas basins

Source: U.S. Energy Information Administration, *Technically Recoverable Shale Oil and Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries Outside the United States, 2013.*

Pipeline connections

China continues to invest in natural gas pipeline infrastructure to link production areas in the western and northern regions of the country with demand centers along the coast and to accommodate greater imports from Central Asia and Southeast Asia.

China had nearly 35,498 miles of main natural gas pipelines at the end of 2013.[84] China's natural gas pipeline network is fragmented, although NOCs are rapidly investing in the expansion of the transmission system to connect more supplies to demand centers along the coast and in the southern regions as well as integrating local gas distribution networks. While the major NOCs operate the trunk pipelines, local transmission networks are operated by various local distribution companies throughout China. China intends to increase its natural gas pipeline network to 74,564 miles by 2020.[85]

CNPC is the key operator of the main gas pipelines, including the West-East Pipelines, and holds nearly 80% of the gas transmission in China.[86] CNPC moved into the downstream gas sector recently through investments in gas retail projects as well as investments in several pipeline projects to facilitate transportation for its growing gas supply. CNPC developed three parallel pipelines, called the Shan-Jing pipelines, linking the major Ordos basin in the North with Beijing and surrounding areas. The third Shan-Jing pipeline began operations in 2011. The NOC completed in 2013 its Zhongwei to Guiyang Gas pipeline, which delivers gas from the West-East pipeline network in the north-central part of the country to the gas markets in southwestern China. Sinopec is also a major player in the downstream transmission sector, operating long-haul pipelines from the Sichuan province to Shanghai and the north central region to Shandong along the northeastern coast.[87] CNOOC operates pipelines mainly along the coastal areas of China.[88]

West-to-East Gas Pipelines

The Chinese government promoted the construction of the West-East Gas Pipeline in 2002 to meet natural gas demand in the eastern and southern regions of the country with production from the western provinces and Central Asian countries. CNPC's/PetroChina's first West-East Gas Pipeline, commissioned in 2004, is China's longest natural gas pipeline at 2,722 miles, with one trunkline and three branch lines. The pipeline links major natural gas supply areas in western China (Tarim, Qaidam, and Ordos Basins) with markets in the eastern part of the country and ends in Shanghai. The initial West-East Pipeline has an annual capacity of 600 Bcf/y and contains many regional spurs along the main route, which has improved the interconnectivity of China's natural gas transport network.

CNPC/PetroChina designed the second West-East trunk pipeline to connect with the Central Asian Gas Pipeline at the border with Kazakhstan and completed construction of this line in 2011. The second West-East Pipeline has a capacity of 1.1 Tcf/y and spans over 5,480 miles, including the trunkline and eight main branch lines. This pipeline transports natural gas from Central Asia and western China's Xinjiang Province to the key demand centers in the southeastern provinces. The western section of the line runs parallel to the first West-East Pipeline to Zhongwei in north-central China, and the eastern section transports natural gas from Zhongwei to southern Guangdong province and Shanghai in the East.

To accommodate greater gas flows from Central Asia, CNPC/PetroChina began constructing the third West-East Pipeline, and the western section of the pipeline was launched in 2014. The eastern section is set to become operational by the end of 2015. This 1.1-Tcf/y pipeline will run parallel to the second West-East Pipeline for most of its length and end in the southeastern provinces of Fujian. Proposals for the fourth and fifth West-East Pipelines are still in the planning stages.[89]

International pipelines

Over the past four years, China has ramped up imports of natural gas via pipelines as production from Central Asia and Myanmar increased and as gas infrastructure in the region improved. China's total imports by pipeline were 1,133 Bcf/y in 2014, up 20% from 2013 imports. Pipeline imports swiftly exceeded LNG imports beginning in 2012.[90] China's first international natural gas pipeline connection, the Central Asian Gas Pipeline (CAGP), transports natural gas through three parallel pipelines from Turkmenistan, Uzbekistan, and Kazakhstan to the border in western China. The CAGP's current capacity is 1.9 Tcf/y (pending the launch of the eastern portion of the third West-East pipeline in 2015) and spans 1,143 miles. The pipeline's first and second phases (Lines A and B) began operations in 2010 with 1.1 Bcf/y of capacity and link to the second West-East Pipeline at the Sino-Kazak border.

CNPC has invested in upstream stakes in Turkmenistan to facilitate gas supply development. The NOC operates the Bagtyyarlyk PSC that currently feeds the CAGP. In 2009, CNPC was awarded a production supply agreement to develop natural gas resources at Turkmenistan's massive Galkynysh gas field and signed a deal with Turkmengaz, the state-owned gas company. China imported more than 2.8 Bcf/d (1,040 Bcf/y) from Turkmenistan and Uzbekistan in 2014 and expects to increase imports as the pipeline capacities on both sides of the border expand. Turkmenistan and China signed another gas supply agreement in 2013 to extend supplies from 1.4 Tcf/y to 2.3 Tcf/y by 2020 as the new Galkynysh field ramps up production following its start of operations in September 2013.[91]

The CAGP is undergoing rapid expansion as more supply agreements are signed and as gas production capacity becomes available from Turkmenistan, Uzbekistan, and

Kazakhstan. In 2010, CNPC signed an agreement with Uzbekistan to deliver 350 Bcf/y (1 Bcf/d) through a transmission line that connects with the CAGP. Uzbekistan began exporting natural gas to China in mid-2012 and quickly ramped up to about 400 MMcf/d by mid-2013. The third phase of the CAGP, known as Line C, added another 880 Bcf/y of capacity from the three Central Asian countries to the CAGP system and became partially operational in May 2014. This line corresponds with the commencement of the third West-East Pipeline on the Chinese side, slated for 2015. Kazakhstan and China formed a joint venture in 2010 to construct a pipeline (the Beyneu-Bozoi-Shymkent pipeline spur) starting in western Kazakhstan and connecting with the other CAGP lines. The second phase of this pipeline from Kazakhstan links this country's western fields to Line C of the CAGP and is scheduled to come online in 2015.[92] CNPC signed agreements with the NOCs of Uzbekistan and Tajikistan in September 2013 to build a fourth line of the CAGP (Line D) that would supply natural gas from the second stage of the Galkynysh field development and traverse Turkmenistan, Uzbekistan, Tajikistan, and Kyrgyzstan. Construction began on Line D in September 2014, and the pipeline is scheduled to increase the system's capacity by another 880 Bcf/y by 2016.[93]

The China-Myanmar natural gas pipeline is likely to boost gas imports to China and diversify its supply in the future. CNPC signed a deal with Myanmar in 2008 to finance the construction of a 420 Bcf/y pipeline from two of Myanmar's offshore blocks to China's Yunnan and Guangxi provinces in the southwestern region. China began importing gas from Myanmar when the pipeline became operational in mid-2013, and by 2014, CNPC imported 116 Bcf.[94] The pipeline is projected to ramp up to full capacity as adjacent gas fields in Myanmar are developed and as the gas price reforms take effect in China, allowing imported gas to be more economically competitive with domestically produced gas.

Russia and China signed a momentous gas deal in May 2014 after a decade of negotiations over the import price and the supply route. China agreed to purchase 1.3 Tcf/y of gas from Gazprom's East Siberian fields for $400 billion over a 30-year period. The proposed Power of Siberia pipeline will connect Russia's eastern Siberian gas fields and Sakhalin Island to northeastern China. The NDRC approved construction of the pipeline on the Chinese side in late 2014 and anticipates the pipeline coming online in 2018. In November 2014, Gazprom and CNPC also signed a Memorandum of Understanding (MOU) for China to import 1.1 Bcf/y from Russia's western Siberian gas fields.[95] However, no price has been determined, and the deal would require infrastructure expansion. China is currently weighing its projected natural gas demand against the costs of the various supply sources, and the gas-on-gas competition within the country is growing.

Key oil and natural gas pipelines in China

Source: PetroChina

Liquefied natural gas imports

Robust growth in natural gas demand in recent years, particularly in the urban coastal areas, has led China to become the world's third-largest LNG importer and to accelerate development of its LNG and pipeline infrastructure.

Since the country built its first regasification terminal, Dapeng LNG, in 2006, natural gas imports have risen dramatically, making China one of the largest LNG consumers in the world. China quickly became the world's third-highest LNG importer, behind Japan and South Korea, in 2012. In 2014, China imported 957 Bcf, a 7% increase from 895 Bcf in 2013 and consumed about 8% of the global LNG trade. Less than half of China's total natural gas imports were in the form of LNG in 2014, because pipeline imports have surpassed LNG purchases.[96] Slower economic growth and the implementation of gas price reforms on the non residential sectors put downward pressure on the pace of LNG import growth in the last half of 2014, although China is set to continue raising LNG imports over the next several years.

Import regasification capacity was 1.9 Tcf/y (5.2 Bcf/d) by the end of 2014, and another 4.4 Bcf/d is expected to be constructed by 2017.[97] As of the beginning of 2015, LNG enters the country through 12 major terminals and a small peaking facility, with another 8 under construction and several other facilities in various stages of planning. China's LNG imports are expected to increase as more terminal capacity comes online. Also, international Asian LNG prices, which are linked to global oil prices, are expected to decline as a result of the lower oil prices and increasing LNG supply following liquefaction capacity build in Australia and North America during the next few years. However, higher market-based LNG prices compared to lower prices from domestic gas sources and the increasing pipeline gas supplied by Central Asia could lead to more competition for LNG imports.

CNOOC is the pioneer developer of LNG regasification terminals and remains a key LNG player in China. The NOC operates seven existing plants, including the Hainan terminal, which came online in 2014. CNOOC completed construction of China's first floating storage and regasification unit (FSRU) in Tianjin at the end of 2013. Generally, floating terminals are more expensive to build, but they can be developed more quickly than land-based terminals.

China's rapidly growing demand and need for seasonal flexibility makes the floating terminals attractive. CNOOC is constructing three regasification terminals in the southern region—Shenzhen/Diefu and Yuedong/Jieyang—and intends to expand three of the company's existing terminals.

Although CNOOC has held a competitive advantage thus far in China's LNG market, the other NOCs and private companies have made inroads into the LNG industry. CNPC entered the LNG market and commissioned its first two regasification terminals in 2011. The NOC operates three existing terminals and is constructing one near Shenzhen in southern Guangdong province. Sinopec entered China's LNG market by commissioning its Qingdao terminal in Shandong province at the end of 2014. Apart from JOVO Group's existing Dongguan terminal in southern China, two other terminals are under construction by private gas distributors and are targeted for completion in 2017.

Chinese NOCs must secure supply prior to gaining government approval to build a regasification terminal, and these firms are faced with competition from other regional buyers, mainly those in Korea and Japan. Chinese companies have signed long-term agreements to deliver at least 6.6 Bcf/d through 2030.[98] Most of these contracts are with Asian firms sourcing LNG from Indonesia, Malaysia, Australia, and Papua New Guinea (PNG). Some contracts are tied to new liquefaction projects located in Australia, PNG, and Russia and are slated to come online between 2014 and 2020. In addition to purchasing supply, Chinese companies are investing in significant equity stakes in Australia's liquefaction projects, particularly ones involving coalbed methane. CNOOC owns a 50% stake in the Queensland Curtis LNG project, and Sinopec owns 25% of Australia Pacific LNG. CNPC also owns 20% of Russia's Yamal LNG and holds a 20-year contract for supplies starting in 2017. Chinese companies signed gas purchase agreements based on their equity stakes in Canadian liquefaction projects that are expected to begin supplying LNG from shale gas operations around 2020. China started actively seeking potential LNG opportunities from North American shale gas plays by investing in upstream developments and LNG projects (LNG Canada and Pacific Northwest LNG) in Canada. Also, some long-term contracts involve gas supply from global LNG portfolios of major international oil companies.

Even though China's key sources for the majority of its LNG are in Southeast Asia, Australia, and Qatar, China is diversifying LNG import sources to meet its rapidly growing natural gas demand. Qatar, which ships gas to China under long-term contracts and spot cargoes, was the largest LNG supplier to China in 2014.

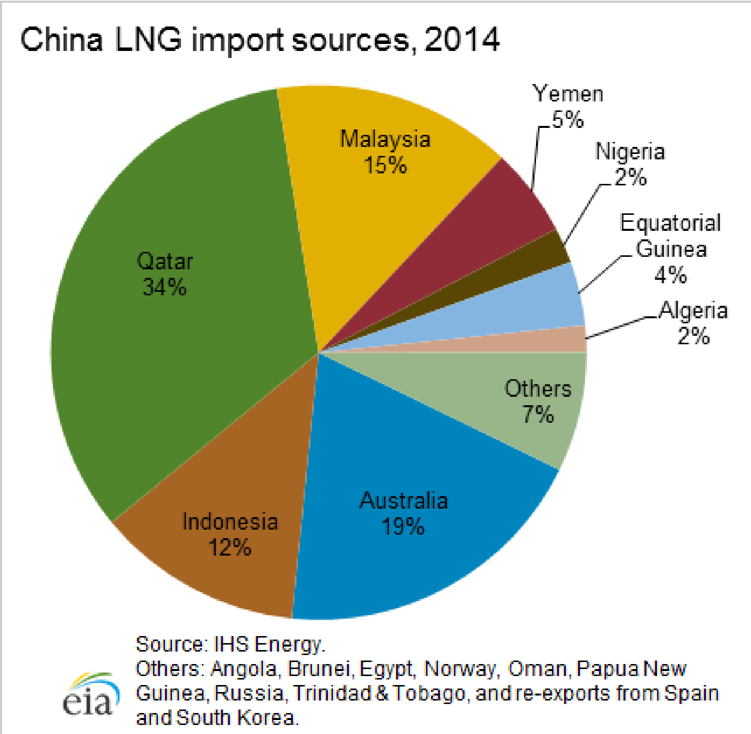
China's higher gas demand and a tighter LNG global supply market over the past few years led to an increase in LNG import prices, reaching a high of nearly $14/MMBtu at the beginning of 2014. CNOOC's first LNG contracts with the traditional Asian suppliers and Qatar were priced at lower rates, and the overall LNG price to China was lower than the average paid by other Asian buyers. As China purchased more short-term and spot cargoes and diversified its long-term contracts, the average LNG purchase price rose to an average of around $11/MMBtu in 2014, according to IHS Energy.[99]

China's major LNG import terminals - current and proposed

Terminal name	Status/online date	Developer	Current / expansion capacity (MMcf/d)

Dapeng/Guangdong	Operational; Second Expansion under construction / 2015	CNOOC (33%); BP, Guangdong Province Consortium	885 / 305
Mengtougou Peaking Facility	Operational	Shanghai Gas Group (Shenergy)	15
Fujian	Operational	CNOOC (60%); Fujian Investment and Development Co. (40%)	665
Shanghai/Yangshan	Operational; Expansion proposed / 2018	CNOOC (45%); Shenergy (55%)	395 / 395
Dalian	Operational; Expansion proposed / 2017	CNPC (75%); Dalian Port Authority; Dalian Construction Investment	395 / 395
Rudong/Jiangsu	Operational; Expansion under construction / 2017	CNPC/Kunlun Energy (55%); Jiangsu Guoxin Investment Group, Pacific Oil & Gas	460 / 395
Zhejiang/Ningbo	Operational; Expansion under construction / 2017	CNOOC (51%); Zhejiang Energy Group, Ningbo Power Development	395 / 395
Zhuhai	Operational; Expansion proposed / 2016	CNOOC (30%); Guangdong Yuedian Group; local gas companies	460 / 460
Tianjin FSRU	Operational; Onshore terminal expansion under construction / 2017	CNOOC (46%); Tianjin Port; local gas companies	290 / 500
Caofeidian/Tangshan	Operational / Expansion proposed	CNPC (51%); Beijing municipal government; Hebei Construction Investment	460 / 395
Dongguan	Operational	JOVO Group	135
Qingdao/ Shandong	Operational / Expansion proposed / 2020	Sinopec	395 / 265
Hainan	Operational; Expansion proposed/ 2017	CNOOC (65%); Hainan Development (35%)	260 / 130
Beihai/Guangxi	Construction / 2015	Sinopec	395
Shenzhen/Diefu	Construction / 2015	CNOOC (70%); Shenzhen Energy (30%)	530
Tianjin Binhai	Construction / 2016	Sinopec	395
Shenzhen	Construction / 2016	CNPC (51%); CLP; Shenzen Gas	395
Yuedong/Jieyang	Construction / 2016	CNOOC	260
Fujian Zhangzhou	Construction / 2017	CNOOC (60%); Fujian Investment Development	395
Zhoushan LNG	Construction / 2017	ENN Group	395
Jiangsu Qidong	Construction / 2016	Guanghui Energy (51%); Shell (49%)	80

Sources: FACTS Global Energy[100], IHS Energy, Reuters, company websites.



Coal

China is the largest producer and consumer of coal in the world and accounts for about half of the world's coal consumption.

China's vast coal resources enable the fuel to remain the mainstay of the country's energy industry and have supported the country's massive economic growth over the past decade. China has been the world's leading coal producer and consumer since the early 1980s and accounted for close to half of the global coal consumption, an important factor in world energy-related CO2 emissions. According to the World Energy Council, China held an estimated 126 billion short tons of proved recoverable coal reserves in 2011, the third-largest in the world behind the United States and Russia, and equivalent to about 13% of the world's total coal reserves.[101]

Coal production rose 9% in 2013 from 2012 to nearly 4.4 billion short tons. Chinese government data indicate that Chinese production and consumption declined by nearly 3% in 2014, the first decline in the coal industry in 14 years. These trends reflect the economic downturn particularly in coal-consuming sectors such as steel and cement, slower electricity demand growth, greater hydroelectricity generation, and China's stricter environmental regulations recently imposed on high-polluting industries, including coal.[102] Although there are 28 provinces in China that produce coal, Shanxi, Inner Mongolia, Shaanxi, and Xinjiang contain most of China's coal resources and virtually all of the large state-owned mines. China currently has about 12,000 coal mines producing primarily bituminous coal and a fair amount of anthracite, lignite, and metallurgical coke.[103] These coal types are used primarily to generate electricity and heat as steam coal and to smelt iron ore and produce steel as metallurgical coal. Much of China's steam coal resources (used for electricity and heating) are located in the north central and northwestern regions, whereas higher-valued coking coal and anthracite reserves are found mostly in the central and coastal parts of China.[104]

Coal comprised nearly 66% of China's total energy consumption in 2012. In 2013, China consumed an estimated 4.0 billion short tons of coal, representing about half of the world total. Coal consumption in 2013 was almost three times higher than it was in 2000, when China's coal demand began swiftly increasing. In 2012, China's coal consumption growth decelerated as a result of the country's industrial slowdown and stricter regulations in major urban areas, particularly in the highly urbanized northeastern region and the Pearl River Basin area in the southeastern region, to reduce environmental pollution. China plans to cap coal consumption at 4.6 billion short tons by 2020.[105] Overall, China plans to close 2,000 small coal mines between 2013 and 2016 to enhance overall efficiency and safety in the sector.[106] About half of China's coal was used for power generation in 2012. The industrial sector, including steel, pig iron, cement, and coke, accounted for 41% of coal use, and the remaining share was consumed by the residential, service, and other sectors.[107] Coal consumption generally tracks economic growth, electricity demand, and industrial sector output.

Prior to 2009, China's domestic coal production generally met all of its consumption requirements, and the country was a net exporter. However, in recent years, the country has significantly increased its import volumes because of higher demand. Historically a net coal exporter, China became a net coal importer in 2009 for the first time in more than two decades. Total imports rose to 360 million short tons in 2013, about 14% higher than 2012 levels. Indonesia and Australia are the largest coal exporters to China, supplying 65% of China's imports in 2013.[108] The government imposed restrictions on coal imports with high ash and sulfur content starting January 2015 and reinstated the import tariff at 3% to 6% to protect market share of domestic producers and pare back the recent excess supply.[109] Coal imports declined in 2014 as a result of slower economic and electricity consumption growth as well as excess domestic supply. China imported about 320 million short tons in 2014, an 11% drop from 2013 levels.[110]

Although coal consumption has remained lower than production over the past several years, imports have risen substantially since 2008, creating large stock builds. The rise in imports from 2008 to 2013 is primarily driven by steady demand growth and the high coal transportation costs resulting from bottlenecks in China's railway system, which makes imported coal economically attractive, especially in southeastern China. Because the bulk of incremental coal produced moved to more remote areas in western and northern China, an increasing amount of coal needed to be transported over long distances from these supply regions to the demand centers along the coast and in the southern and eastern provinces via rail and truck. In recent years, the country has struggled with transportation bottlenecks in shipping coal to market, creating regional imbalances. Also, international coal prices, which have declined overall since 2011 and at times have fallen below China's domestic prices, have made imports more commercially competitive with China's own coal supply, particularly for electric utilities along the coastal regions.[111]

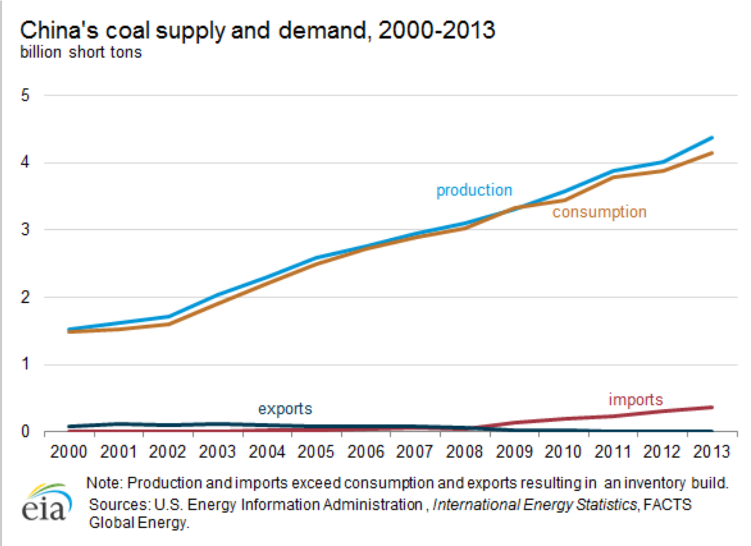
As coal demand growth has eased since 2012, the country has witnessed an oversupply of coal and rising inventories. Despite this surplus, some of China's major coal producers, particularly in key coal-producing provinces in north central and northwestern China that have larger and lower-cost mines, continued to increase production, albeit at a more moderate pace. Producers in these regions, primarily the state-owned enterprises, are able to reduce their unit costs through higher output and economies of scale. However, the majority of coal companies in China were unprofitable in 2014 as coal prices continued to be low. Some small mines in Inner Mongolia that produce lower-calorific coal and transport most of their coal outside of the region have suspended their output in response to weaker demand and revenue losses.[112] Also, Shanxi province responded to the oversupply in 2015 by ending the approval of all new coal mine projects until 2020.[113] Mines that are able to keep their costs low in the current low coal price environment will be able to maintain higher production levels.

China reformed the coal tax structure at the end of 2014. The resource tax imposed on coal mining companies shifted from being a volume-based system to being a value-based system, allowing local governments to collect between 2% to 10% of the value of domestic coal sold. As part of the reform, China's State Council removed all surcharges and fees for coal production. This reform allows coal producers to reduce some of the production costs from high taxes paid to the local governments, especially in a low-price environment.[114]

In 2013, China began addressing the regional imbalance of coal supply and demand through investments in greater railway capacity, storage and coal processing facilities, and higher electricity transmission capacity to enable electricity generated from coal to travel long distances to demand centers. China commenced operation of its third and longest coal-dedicated rail line running from the north central Shanxi province to the northeastern Shandong province at the end of 2014.[115]

China's coal industry has traditionally been fragmented among large state-owned coal mines, local state-owned coal mines, and thousands of town and village coal mines. The top state-owned coal companies, including Shenhua Group and China National Coal Group (China's largest coal companies), produce about 50% of the country's coal. Local state-owned companies produce about 20%, and small town mines produce 30% of the coal output each year.[116] As the government regulations and economic factors from a low-price coal environment force more inefficient and small mines to close, the share of production from large state-owned companies is likely to rise. China has about 10,000 small local coal mines that have insufficient investment, outdated equipment, and poor safety practices.[117] These mines are typically inefficient and are a source of pollution. The goal of industry consolidation is to attract greater investment in new coal technologies and to improve the safety and environmental record of coal mines.

In contrast to the past, China is becoming increasingly open to foreign investment in the coal sector in an effort to modernize existing large-scale mines and to introduce new technologies in the coal industry. State-owned enterprises partner with foreign investors in the coal sector. Areas of interest in foreign investment include coal-to-liquids, CBM production, coal-to-gas, and slurry pipeline transportation projects.

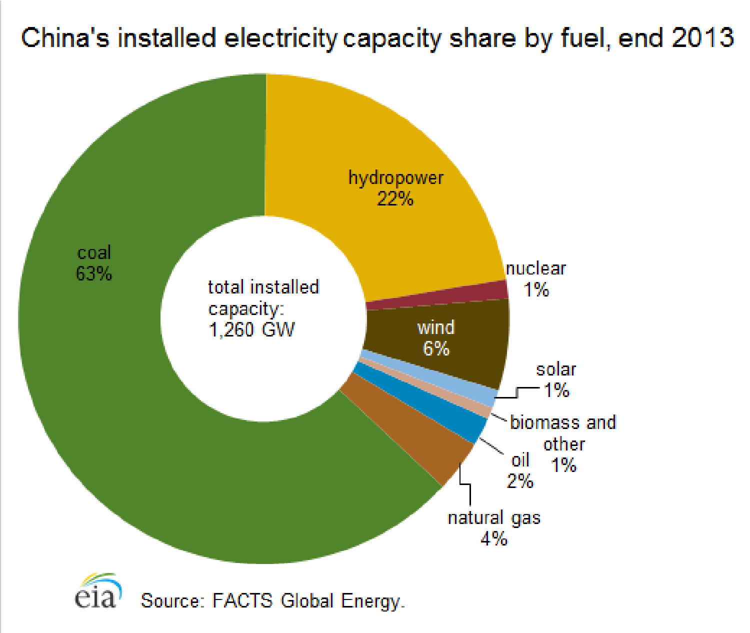


Electricity

China became the world's largest power generator in 2011. Coal and hydroelectricity continue to be the leading sources of the country's electricity generation and installed capacity. China is moving to generate more power from nuclear, renewable sources, and natural gas in efforts to address environmental concerns and diversify its electricity generation fuel slate.

China is the world's largest power generator, surpassing the United States in 2011. Net power generation was an estimated 5,126 Terawatthours (TWh) in 2013, up 7.5% from 2012, according to EIA estimates. Electricity generation has more than doubled since 2005, although power generation, which is mostly driven by economic and industrial demand, decelerated after the global financial recession in 2008 and 2009 and, again, starting in 2012. The industrial sector currently accounts for almost three-quarters of China's electricity consumption.[118] Annual growth in electricity generation was a decade-low 4% in 2014, according to preliminary data from NBS. This deceleration was mainly a result of significant slowdown of activity in heavy industries, especially the steel industry, as well as weather.[119]

China plans to rely on more electric generation from nuclear, renewable sources, and natural gas to replace some coal, with the goal of reducing carbon emissions and the heavy air pollution in urban areas. China's installed electricity generating capacity was an estimated 1,260 gigawatts (GW) at the beginning of 2014. China's capacity rose by almost 90 GW from a year earlier and doubled from 630 GW in 2006. As China's generating capacity expanded over the past several years in response to its economic development, the country's capacity grew to be the highest in the world. Installed capacity is expected to grow over the next decade to meet rising demand, particularly in large urban areas in the eastern and southern regions of the country. EIA projects installed capacity will double to 2,265 GW by 2040, propelled by a combination of capacity from coal, nuclear, and renewable sources.[120] Fossil fuel-fired power capacity has historically made up about three-fourths of installed capacity, and coal continued to dominate the electricity mix with 63% of total capacity in 2013. However, non-fossil fuels have been increasing their portion of installed capacity over the past few years.



Sector organization

China's electric generation is controlled by state-owned holding companies, although limited reforms have opened up the electricity sector to some private and foreign investments. China is seeking to improve system efficiency and facilitate investment in the power grids.

In 2002, the Chinese government dismantled the monopoly State Power Corporation (SPC) into separate generation, transmission, and services units. Since the reform, China's electricity generation sector has been controlled by five state-owned generation companies —China Huaneng Group, China Datang Corporation, China Huadian Corporation, China Guodian Corporation, and China Power Investment Corporation. These five companies generate nearly half of China's electricity. Much of the remainder is generated by local-owned enterprises or by independent power producers (IPPs), often in partnership with privately listed arms of the state-owned companies. Deregulation and other reforms have opened the electricity sector to foreign investment, although investments have been limited so far.[121]

During the 2002 reforms, the SPC divided all of its electricity transmission and distribution assets into two new companies, the China Southern Power Grid Company and the State Grid Corporation of China, which operate the nation's seven power grids. The State Grid Corporation operates power transmission grids in the north and central regions, while China Southern Power Grid Company handles those in the south.[122] China also established the State Electricity Regulatory Commission (SERC), responsible for the regulation enforcement of the electricity sector and facilitation of investment and competition to alleviate power shortages. As part of the current Chinese leadership's efforts to streamline government agencies, the government eliminated SERC in March 2013 and transferred the agency's duties to the NEA.[123] China is seeking to improve system efficiency and the interconnections between the grids through ultra-high-voltage lines, as well as to implement a smart grid plan. The first phase was completed in 2012, and subsequent phases are slated for completion by 2020.[124]

Electricity prices

On-grid (electricity sold by generators to the grid) and retail electricity prices are determined and capped by the NDRC. The NDRC also determines the price that coal companies should receive from power producers for a certain level of electricity. China attempted to reform electricity prices in 2004 by initiating a policy that will pass through fuel costs, although on-grid prices were modified infrequently. As a result, high coal prices in 2011 and lower government-controlled power tariffs contributed to financial losses for electric generators. Coal prices declined in 2012 and have remained relatively low for the past few years. These lower prices prompted the government to lower on-grid tariff rates for coal-fired power plants, giving power producers some financial reprieve.[125] As reforms in the natural gas pricing mechanism took place, electricity tariffs for gas-fired power plants were linked to higher natural gas prices.[126] Cost savings by power generators is designated for funding renewable energy subsidies. Additionally, the NDRC doubled the surcharge in 2013 on renewable energy use to all end-users excluding residential and agriculture sectors. These measures were designed to encourage more investment in renewable energy infrastructure and to facilitate a greater shift towards using alternative fuels.[127]

Electricity generation

The Chinese government has prioritized the expansion of nuclear, natural gas-fired, and renewable power plants as well as the electricity transmission system to connect more remote power sources to densely populated areas along the coasts. Although coal remains the primary source of electricity generation, China is seeking ways to curb expansion of coal-fired generation.

Rapid growth in electricity demand this past decade spurred significant investment in new power stations, particularly in fossil fuel-fired capacity. Although much of the new investment over the past several years was earmarked to alleviate power supply shortages, the economic crisis of 2008 and the deceleration of Chinese economic growth after 2012 resulted in a slower demand growth for electricity. Power demand typically follows economic cycles and rebounded in 2010 as the Chinese economy recovered from the recession. However, annual power demand growth slowed considerably to just 5% in 2012 and 7.5% in 2013 as a result of weaker industrial output and slower economic growth.[128] The government is investing in development of the transmission network, integration of regional networks, and construction of new generating capacity.

Fossil fuels

Fossil fuels, primarily coal, made up 77% of power generation sources and nearly 70% of installed capacity. Coal is expected to remain the dominant fuel in the power sector in the coming years, while natural gas is set to increase and replace some of the coal-fired capacity in the northeastern and southeastern coastal areas where power demand is higher. Oil-fired generation is expected to remain small in the next two decades. In 2013, China generated about 3,937 TWh from fossil fuel sources, up about 7% from 2012. Installed fossil fuel-fired capacity was 863 GW at the end of 2013.[129]

Because of the large amount of domestic reserves, coal will continue to lead the fuel slate for power generation, even as China diversifies its fuel supply and uses cleaner fuels. Coal serves as the primary source of fuel for power, although plant utilization rates have declined slightly from 60% in 2011 to 56% in 2014.[130] As happened with coal mining, the Chinese government is closing small and inefficient plants to modernize the coal fleet in favor of larger, more efficient units as well as technologically advanced ultra-supercritical units, which operate at the highest levels of pressure and temperature for a coal plant. Also, China has prohibited companies from building new coal-fired power plants around three major cities—Beijing, Shanghai, and Guangzhou—as air pollution rates have become a problem in recent years. China is building more coal-fired capacity closer to the inland coal-producing centers and expanding electricity transmission to alleviate air pollution from major urban areas along the coast.

Natural gas currently plays a minor role in overall power generation and accounted for only 43 GW of installed capacity at the end of 2013. However, the government plans to invest heavily in more power plants fueled by natural gas, a growing marginal fuel source. In 2014, companies added another 12 GW to the electric grid, and 18 GW of gas-fired power is under construction.[131] China is able to obtain gas from increasing production of domestic sources as well as several import alternatives, but coal still remains the less expensive fuel except in the large southern coastal cities where natural gas is more available and competitive. Natural gas serves as a fuel source primarily during peak demand for power, and storage for natural gas is extremely low. These factors affect natural gas supply available for electricity. The utilization rate of gas-fired plants averaged 30% in 2013.[132]

There are several examples of China's effort to bring new efficient gas-fired units online, some in conjunction with new LNG terminals such as those in Guangdong and Shanghai. Also, Beijing authorities are replacing all of its coal-fired facilities, representing 2.7 GW of capacity, with more efficient gas-fired plants by 2016. By early 2015, Beijing had closed three of the four major coal-fired power plants in its campaign to significantly reduce coal consumption by 2017.[133] Overall, China's effort to shift coal-fired generation to more gas-fired generation in the long term depends on the country's ability to increase gas supply through domestic production and imported sources, to improve the infrastructure for gas transmission, and to regulate coal use.

Nuclear

Although nuclear generation is a small portion of the country's total power generation portfolio, China is actively promoting nuclear power as a clean, efficient, and reliable source of electricity generation. China generated 106 TWh of nuclear power in 2013, making up only 2% of total net generation. However, the country rapidly expanded its nuclear capacity in the past few years, which will likely boost nuclear generation in the next few years. China's net installed nuclear capacity was more than 23 GW as of April 2015 after the country added ten reactors with more than 10 GW since the beginning of 2013.[134] All of China's nuclear plants are located along the east coast and southern parts of the country, but China plans to assess the construction of inland facilities, according to its latest energy strategy plan. By April 2015, Chinese companies were constructing an additional 23 GW of capacity, more than one-third of the global nuclear power capacity currently being built. These plants are slated to become operational by 2019 and roughly double China's current capacity.[135] Several more facilities are in various stages of planning.

Following Japan's Fukushima Daiichi nuclear accident in March 2011, China suspended government approvals for new nuclear plants until safety reviews of all facilities were completed and a safety framework was approved by the State Council. New plant approvals and construction resumed in October 2012, and the commissioning of new capacity has steadily increased. China's government plans to boost operational nuclear capacity to 58 GW and to have 30 GW of capacity under construction by 2020.[136] As part of this effort, the government is encouraging private investment in nuclear project development and a more expeditious approval process for currently proposed facilities.[137]

China also intends to build strategic and commercial uranium stockpiles through overseas purchases and continue to develop domestic production in Inner Mongolia and Xinjiang. Also, China is developing nuclear fuel reprocessing facilities expected to come online by 2017, according to the World Nuclear Association.[138]

Hydroelectricity and other renewables

The Chinese government has a stated goal to produce at least 15% of overall energy consumption by 2020 from non-fossil fuel sources as the government addresses environmental issues.[139] Chinese companies invested a record-level $89 billion in renewable energy projects in 2014, 31% higher than 2013 investments. China, now the world's leading investor in the renewable energy sector, will likely continue sizeable investments through the next five-year period to reach its renewable energy and carbon emission goals.[140] China is encouraging investment in renewable energy and accompanying transmission infrastructure through a variety of financial and economic incentives.

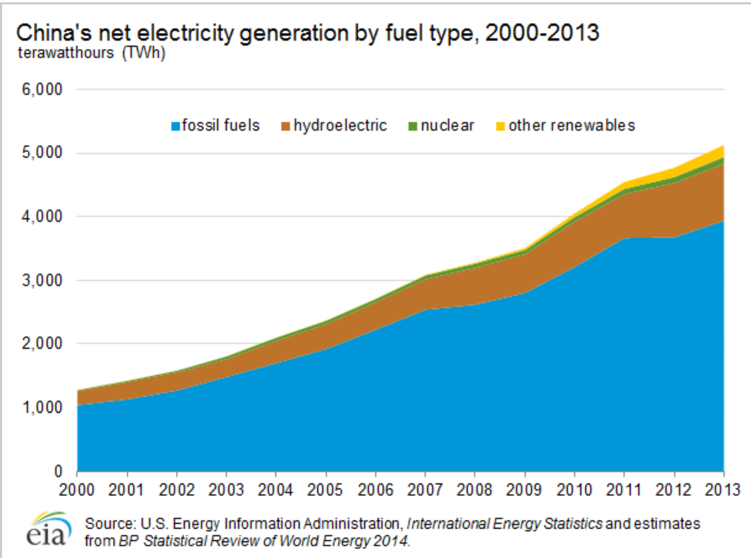
Because of its cost-effectiveness and sizeable resource potential, hydroelectricity has become China's key source of renewable energy generation. China was the world's largest producer of hydroelectric power in 2013. The country generated about 894 TWh of net electricity from hydroelectricity, representing 18% of the country's total net electricity generation, according to EIA estimates. After a severe drought in the southwestern region that resulted in lower hydroelectric production in 2011, and the completion of the Three Gorges Dam in 2012, hydroelectric generation growth rebounded in 2012.

Installed hydroelectric generating capacity was 280 GW at the end of 2013, according to FGE, accounting for more than one-fifth of total installed generating capacity in China. The world's largest hydropower project, the Three Gorges Dam along the Yangtze River, was completed in July 2012 and includes 32 generators with a total maximum capacity of 22.5 GW. The dam generated almost 99 TWh in 2014, the world's highest level of hydropower generation in any year.[141] Another massive hydropower dam and China's third-largest, Xiangjiaba, entered operations in 2013 with four of its eight turbines. The 6.4-GW project, also along the Yangtze River, is slated for completion in 2015.[142] The Chinese government plans to increase hydroelectric capacity to 350 GW by the end of 2020.[143] However, China has faced some delays on projects resulting from environmental concerns and complications of population displacement needed to build the dams.

In 2013, China was the world's second-largest wind producer, generating about 132 TWh, a level about 38% higher than in 2012. China's installed on-grid wind capacity was 76 GW at the end of 2013 and has grown exponentially since 2005. However, absolute wind power capacity stood at about 91 GW, representing a shortage of transmission infrastructure to connect wind farms to the electric grid.[144] The government has encouraged investment in grid development and measures to improve flexibility in the transmission system, especially during peak hours. The NEA reported that on-grid capacity rose to 96 GW in 2014, indicating infrastructure development is rapidly occurring.[145] As part of its renewable energy targets, the NDRC aims to increase wind capacity to 200 GW by the end of 2020.

China is also aggressively investing in solar power and hopes to increase capacity from 15 GW at the end of 2013 to 100 GW by the end of 2020. The NDRC began providing generous financial incentives for solar equipment manufacturers in 2012, which have led to a boom in large-scale solar projects.[146]

Biomass use in China is relatively small, mostly for heating and cooking in rural areas, and for small-scale power projects.[147] The NDRC has created price and tax incentives for investments in biomass and waste incineration projects through feed-in tariffs. By 2014, the total installed biomass power capacity in China was 10 GW, with a targeted capacity of 30 GW by 2020.[148]



Notes

- Data presented in the text are the most recent available as of May 14, 2015.
- Data are EIA estimates unless otherwise noted.

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