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Japan



Last Updated: October 29, 2013 ([Notes](#))

[full report](#)

## Overview

*Japan is the world's largest liquefied natural gas importer, second largest coal importer, and third largest net oil importer.*

Japan has limited domestic energy resources. It meets less than 15% of its own total primary energy use from domestic sources. It is the third largest oil consumer and importer in the world behind the United States and China. Furthermore, it ranks as the world's largest importer of liquefied natural gas (LNG) and second largest importer of coal behind [China](#).

In light of the country's lack of sufficient domestic hydrocarbon resources, Japanese energy companies have actively pursued participation in upstream oil and natural gas projects overseas and provide engineering, construction, financial, and project management services for energy projects around the world. Japan is one of the major exporters of energy-sector capital equipment, and has a strong energy research and development (R&D) program supported by the government. This program pursues energy efficiency measures domestically in order to increase the country's energy security and reduce carbon dioxide (CO<sub>2</sub>) emissions.

In March 2011, a 9.0 magnitude earthquake struck off the coast of Sendai, Japan, triggering a large tsunami. The damage to Japan's resulted in an immediate shutdown of about 10 GW of nuclear electric generating capacity. Between the 2011 Fukushima disaster and May 2012, Japan lost all of its nuclear capacity as a result of scheduled maintenance and lack of government approvals to return to operation. Two nuclear reactors were re-commissioned in July 2012 and represented the only source of nuclear power in the country for more than one year. However, these two reactors were removed from service again in September 2013, eliminating the country's nuclear capacity for a second time in more than 40 years.

Nuclear generation in Japan represented about 26% of the power generation prior to the 2011 earthquake and was one of the country's least expensive forms of power supply. Japan replaced the significant loss of nuclear power with generation from imported natural gas, low-sulfur crude oil, fuel oil, and coal that caused a higher price of electricity for its government, utilities, and consumers. Fuel import cost increases have resulted in Japan's top 10 utilities losing over \$30 billion in the past two years. Japan spent \$250 billion on total fuel imports in 2012, a third of the country's total import charge. Despite strength in export markets, the yen's depreciation and soaring natural gas and oil import costs from a greater reliance on fossil fuels continued to deepen Japan's recent trade deficit throughout 2013.

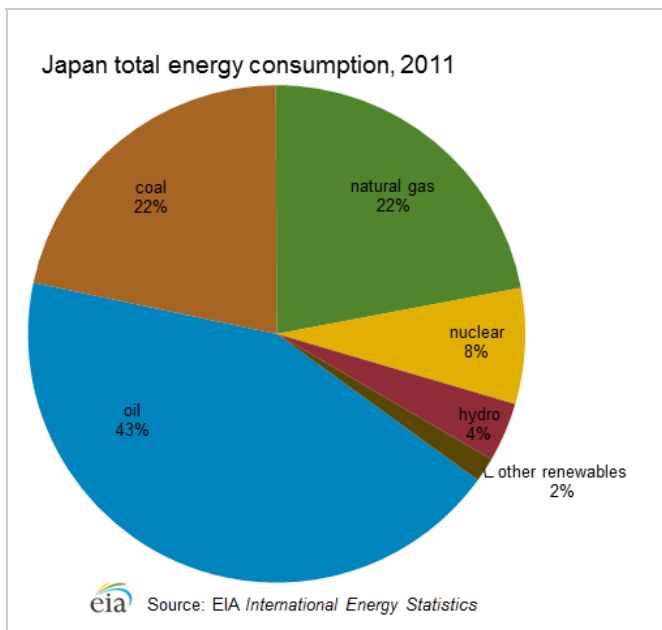
Japan's current government wants to resume using nuclear energy with necessary safety measures. The government believes that the use of nuclear energy is necessary to reduce current energy supply strains and high energy prices faced by Japan's industries and end-users. This effort occurs in the context of the government's focus on reversing two decades of economic stagnation in Japan and providing economic revitalization through public infrastructure spending, monetary easing, labor market reform, and business investment.



Source: CIA, World Factbook

## Total primary energy consumption

In the wake of the Fukushima nuclear incident, Japan's energy fuel mix has shifted as natural gas, oil, and renewable energy provide larger shares and supplant some of the nuclear fuel. Oil remains the largest source of primary energy in Japan, although its share of total energy consumption has declined from about 80% in the 1970s to 43% in 2011. The decline in oil use occurred as a result of increased energy efficiency and the expanded use of nuclear power and natural gas. Coal continues to account for a significant share of total energy consumption, although natural gas is increasingly important as a fuel source and is currently the preferred fuel of choice to replace the nuclear shortfall. Natural gas rose from 18% in 2010 to 22% of total primary consumption in 2011. Before the 2011 earthquake, Japan was the third largest consumer of nuclear power in the world, after the United States and France, and nuclear power accounted for about 13% of the country's total energy in 2010. In 2011, the nuclear energy share fell to 7% of the total energy consumption. Hydroelectric power and other renewable energy comprise a relatively small percentage of total energy consumption in the country, although renewable energy is becoming increasingly significant as a fuel source.



## Oil

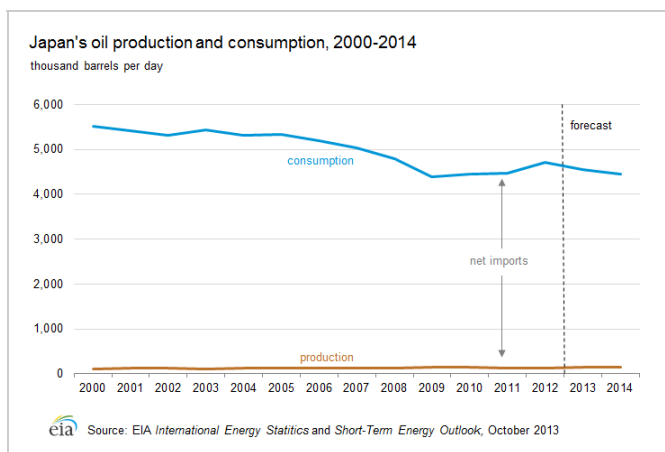
*Because Japan's oil resources are very limited, the country relies almost solely on imports to meet its oil consumption needs.*

Japan has very limited domestic oil reserves, amounting to 44 million barrels as of January 2013, according to the *Oil and Gas Journal* (OGJ). Japan's domestic oil reserves are concentrated primarily along the country's western coastline. Offshore areas surrounding Japan, such as the East China Sea, also contain oil and natural gas deposits. However, development of these zones is held up by competing territorial claims with China. The two countries reached an accord in 2008 to jointly explore four natural gas fields and equally invest in the development of two fields – Chunxiao/Shirakaba and Longjing/Asunaro. 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 and China's installation of a production platform in the contested area in 2013. (See [East China Sea](#) country analysis brief.)

Consequently, Japan relies almost solely on imports to meet its oil consumption needs. Japan maintains government-controlled oil stocks to ensure against a supply interruption. According to the International Energy Agency, total strategic crude oil stocks in Japan were 590 million barrels at the end of December 2012, where 55% of those were government stocks and 45% commercial stocks.

Japan consumed over 4.7 million barrels per day (bbl/d) of oil in 2012, making it the third largest petroleum consumer in the world, behind the United States and China. However, oil demand in Japan has declined overall since 2000 by nearly 15%. This decline stems from structural factors, such as fuel substitution, a declining population, and government-mandated energy efficiency targets. In addition to the shift to natural gas in the industrial sector, fuel substitution is occurring in the residential sector as high prices have decreased demand for kerosene in home heating. Japan consumes most of its oil in the transportation and industrial sectors, and it is also highly dependent on naphtha and low-sulfur fuel oil imports. Demand for naphtha has fallen as ethylene production is gradually being displaced by petrochemical production in other Asian countries. Demand for low-sulfur fuel oil and direct use of crude oil rose substantially in 2012 as these fuels replaced some nuclear electric power generation and supported the post-disaster reconstruction works. Japan's oil consumption rose by 244,000 bbl/d in 2012 from the 2011 level. EIA assumes that net total oil consumption will decline starting in 2013 as nuclear capacity comes back online.

The Japanese government's policy has emphasized increased energy conservation and efficiency and a lower dependency on oil imports. The government generally aims to reduce the share of oil consumed in its primary energy mix. Among the large developed world economies, Japan has one of the lowest energy intensities, as high levels of investment in R&D of energy technology since the 1970s have substantially increased energy efficiency.



## Sector organization

Although Japan is a minor oil producing country, it has a robust oil sector comprised of various state-run, private, and foreign companies. Until 2004, Japan's oil sector was dominated by the Japan National Oil Corporation (JNOC), which was formed by the Japanese government in 1967 and was charged with promoting oil exploration and production domestically and overseas. In 2004, JNOC's profitable business units were spun off into new companies to introduce greater competition into Japan's energy sector. Many of JNOC's activities were taken over by the Japan Oil, Gas and Metals National Corporation (JOGMEC), a state-run enterprise charged with aiding Japanese companies involved in exploration and production overseas and promotion of commodity stockpiling domestically. New companies were formed, of which the two largest are Inpex, now Japan's largest oil and gas company, and the Japan Petroleum Exploration Company (Japex).

Private Japanese firms dominate the country's large and competitive downstream sector, as foreign companies have historically faced regulatory restrictions. But over the last several years, these regulations have been eased, which has led to increased competition in the petroleum-refining sector. Chevron, BP, Shell, and BHP Billiton are among the foreign energy companies involved in providing products and services to the Japanese market as well as being joint venture (JV) partners in many of Japan's overseas projects.

## Domestic exploration and supply

In 2012, Japan's total oil production was roughly 136,000 bbl/d, of which only 5,000 bbl/d was crude oil. The vast majority of Japan's oil supply comes in the form of refinery gain, resulting from the country's large petroleum refining sector. Japan has 148 producing oil wells in over 12 fields, according to the OGJ.

## Overseas exploration and production

*Japan's limited hydrocarbon reserves and its need to secure energy imports are the incentives the government uses to support upstream Japanese companies in their quest to purchase overseas oil and natural gas equity.*

Japanese oil companies have sought participation in exploration and production projects overseas with government backing because of the country's lack of domestic oil resources. The government's energy strategy plan encourages Japanese companies to increase energy exploration and development projects around the world to secure a stable supply of

oil and natural gas. The Japan Bank for International Cooperation supports upstream companies by offering loans at favorable rates, thereby allowing Japanese companies to bid effectively for projects in key producing countries. Such financial support helps Japanese companies to purchase stakes in oil and gas fields around the world, reinforcing national supply security while guaranteeing their own financial stability. The government's goal in the 2010 Strategic Energy Plan is to import 40% of the country's total crude oil imports from Japanese-owned concessions by 2030, up from an estimated 23% in 2010. As a result of the 2011 earthquake and a pressing need to secure energy supplies, Japan is promoting even more investment in overseas oil and gas operations as well as technology exchanges with various countries.

Japan's overseas oil projects are primarily located in the Middle East and Southeast Asia. Japanese oil companies involved in exploration and production projects overseas include: Inpex, Cosmo Oil, Idemitsu Kosan Co., Japan Energy Development Corporation, Japex, Mitsubishi, Mitsui, Nippon Oil, and others. Many of these companies are involved in small-scale projects that were originally set up by JNOC. However, many have invested in high-profile overseas upstream projects in recent years.

### Japan's major upstream overseas oil projects

Country	Project	Japanese company equity	Project details
Kuwait and Saudi Arabia Neutral Zone	Khafji and Hout fields	Japanese-owned Arabian Oil Company (AOC) once held a 40% stake in exploration for the Khafji and Hout oil fields. Expirations led to a limited, technical role.	100,000 bbl/d purchase contract from Khafji field until 2023.
United Arab Emirates (UAE)	Adma Block	Inpex: 12% stake in 4 fields and a 40% stake in 1 field	Fields began production in 1982. Offshore UAE and Qatar, Mubarraz and two other fields are 100% owned by consortium of JX Nippon, Cosmo Oil, Tokyo Electric, Chubu Electric, and Kansai Electric.
Iraq	Garraf oilfield in Southern Iraq	Japex: 30%	Production began in 2013, with a production target plateau of 230,000 bbl/d by 2017.
Congo	11 offshore oil fields	Inpex: 32%	Production began in 1975. The contract has been extended to 2023.
Angola	Offshore Block 14	Inpex: 9.99% through a JV with Total	Purchased share in 2013. Total production is 160,000 bbl/d
Indonesia	Mahakam Block and Attaka Unit, Offshore Kalimantan Island	Inpex: 50%	Fields began producing in 1972. Inpex has a 20-year production contract through 2017 and is currently negotiating to extend it. Crude and condensate are shipped mainly to oil refineries and power utilities in Japan.
Australia	Van Gogh and Ravensworth oil fields	Inpex: 47.5% of Van Gogh, 28.5% of Ravensworth	Both fields began production in 2010.
Australia	Timor Sea Joint Development Area	Inpex: 35% of Kitan oil field	Production began in 2011.
Australia	NW Shelf Mutineer and Exeter fields	JX Nippon: 25%	
Vietnam	Nam Rong/Doi Moi offshore oil fields	Idemitsu Kosan: 15%	Began production in 2010. Idemitsu, JX Nippon, and Teikoku Oil hold interests in two other Vietnamese offshore fields currently under exploration.
Papua New Guinea		Nippon Oil and Mitsubishi joint venture: 8.3% to 73.5% interests in various fields under exploration and development including onshore blocks at Kutubu and Moran.	

Azerbaijan	Azeri-Chirag-Guneshli Project (ACG)	Inpex: 11%	Estimated production: 0.7 million bbl/d.
Kazakhstan	North Caspian Sea project, Kashagan oil field	Inpex: 7.56%	Initial production began in 2013. Peak production target is 1.5 million bbl/d by 2020.
Russia	Sakhalin-I	Sakhalin Oil and Gas development Company (SODECO), a consortium of public and private Japanese oil companies: 30%	
Russia	Sakhalin-II	Mitsui and Mitsubishi: combined interest of 22.5%	Oil and gas field including oil reserves of approximately 1.2 million barrels of oil and condensate.
Norway	North Sea offshore	Idemitsu Kosan owns varying interests in seven producing fields: Snorre, Tordis, Vigdis, Vega, Statfjord East, Sygna, and Fram, as well as exploration opportunities.	
United Kingdom	North Sea offshore	Idemitsu Kosan holds 28 licenses including 9 producing fields. Interests in exploration and development of 3 licensed blocks west of the Shetland Islands.  Nippon Oil has stakes ranging from 2% to 85% in several North Sea offshore fields.	
Brazil	Frade block, Northern Campos Basin	Consortium of Inpex, JOGMEC, and Sojitz Corporation: 18.3%	Production began in 2009; peak production of 79,000 bbl/d was reached in 2011.
Canada	Alberta oil sands syncrude project	JX Nippon: 5%	Current production capacity is 350,000 bbl/d.
Canada	Athabasca oil sands project, Alberta (Hangingstone block)	Japex: 75%	
United States	Gulf of Mexico exploration and development	JX Nippon: ownership of fields varies between 11.6% and 100%	
United States	Permian basin	Sumitomo 30% of Devon's tight oil project	

Sources: Company web sites, PFC Energy, Platts, Rigzone

## Oil imports

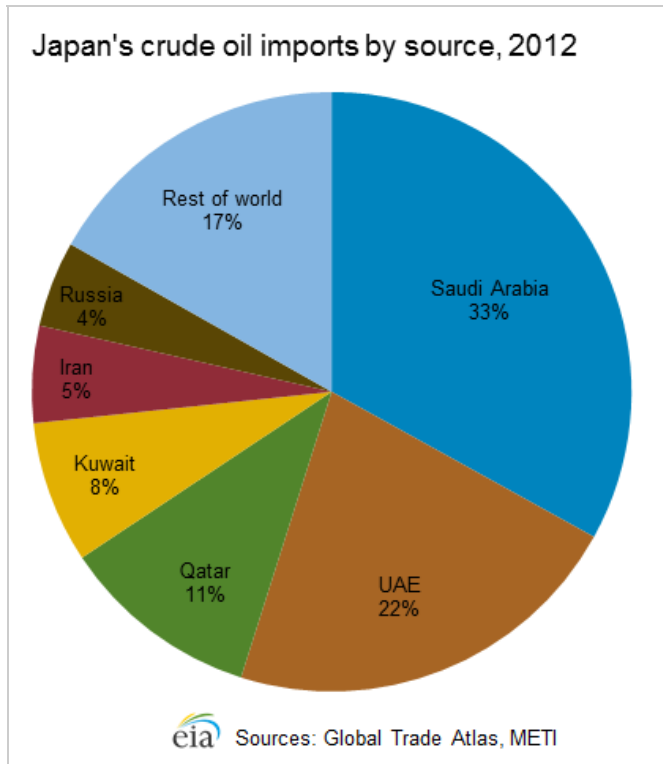
*Japan, the third largest global net oil importer, is highly dependent on the Middle East for the majority of its supply. It is seeking to diversify its supply sources in Russia, Southeast Asia, and West Africa.*

Japan was the third-largest net importer of total oil in the world after the United States and China in 2012, having imported about 4.6 million bbl/d. After the Fukushima incident, Japan has increased imports of crude oil for direct burn in power plants. The country is primarily dependent on the Middle East for its crude oil imports, as roughly 83% of Japanese crude oil imports originated from the region in 2012, up from 70% in the mid-1980s. Saudi Arabia is the largest source of imports, making up 33% of the import portfolio or over 1.2 million bbl/d of crude oil, and [UAE](#), [Qatar](#), [Kuwait](#), and [Iran](#) are other sizeable sources of oil to Japan.

Japan's imports of crude oil and condensate from Iran have decreased since mid-2012 as a result of the latest rounds of U.S. and European Union sanctions targeting Iran's oil exports, and Japanese refiners are replacing Iranian oil with other Middle Eastern supplies.

Japanese imports from Iran were 78,121 bbl/d in the second half of 2012, down 31% from 113,534 bbl/d in the first half of 2012. By the first half of 2013, crude oil supplies from Iran rebounded to 92,254 bbl/d, according to the Ministry of Economy, Trade and Industry (METI). Japan is leveraging its nuclear capabilities to secure nuclear cooperation and technology transfer deals and strengthen ties with Middle Eastern countries in exchange for long-term oil supplies. It signed a technology transfer deal with the UAE in 2013.

Also, Japan is currently looking towards [Russia](#), Southeast Asia, and Africa to geographically diversify its oil imports. As of mid-2011, Japan was replacing some of the lost nuclear power generation with low sulfur heavy crudes from sources in West Africa ([Gabon](#) and [Angola](#)) and Southeast Asia (Vietnam, [Indonesia](#), and [Malaysia](#)).



## Pipelines

For a consumer of its size, Japan has a relatively limited domestic oil pipeline transmission system. Crude oil and petroleum products are delivered to consumers mainly by coastal tankers and tank trucks, and, to a lesser degree, by railroad tankers and pipelines.

Russia's Eastern Siberia-Pacific Ocean pipeline (ESPO), a 2,900 mile pipeline running from Taishet, Siberia, to the Kozmino Bay Oil Terminal on the Pacific Ocean, has sent crude oil to Japan since 2009. Since then, Japan significantly raised crude oil imports from Russia, which now contributes around 4% of Japan's total imports.

## Refining

According to the Petroleum Association of Japan (PAJ), Japan had 4.3 million bbl/d of crude oil refining capacity at 25 facilities as of August 2013. It has the second-largest refining capacity in the Asia-Pacific region after China. JX Nippon is the largest oil refinery company in Japan and operates seven refineries with about 1.6 million bbl/d of capacity. Other key operators include Idemitsu Kosan, Cosmo Oil, and TonenGeneral Sekiyu. In recent years, the refining sector in Japan has had excess capacity because domestic petroleum product consumption has declined from the contraction of industrial output and the mandatory blending of ethanol into transportation fuels. As a result, Japan has scaled back refining capacity from about 5.3 million bbl/d in 2000 according to PAJ. In addition to declining domestic demand, Japanese refiners now must compete with new state-of-the-art

refineries in emerging Asian markets. Currently, private refiners in Japan are required to maintain petroleum product stocks equivalent to at least 70 days of consumption, which imposes large additional costs to these companies. This regulation was relaxed to 67 days after the Fukushima incident.

The Japanese government is seeking to promote operational efficiency in the refining sector, including increasing refinery competitiveness, which may lead to further refinery closures in the future. In 2010, METI announced an ordinance that would raise refiners' mandatory cracking-to-crude distillation capacity ratio from 10% to 13% or higher by March 2014. Closures announced so far, along with the METI rule, are expected to result in lower refining capacity by nearly 1 million bbl/d between April 2010 and April 2014, bringing total refining capacity to about 3.9 million bbl/d. FACTS Global Energy also anticipates another 0.5 million bbl/d refining capacity reduction by 2020 as oil demand continues its decline as a result of an aging population, energy conservation measures, some nuclear facilities returning to serve the power sector, and financial burdens of dealing with Japan's old refining plants.

The March 2011 earthquake in northeastern Japan caused an immediate shutdown of six refineries with 1.4 million bbl/d or about 30% of the total current capacity. However, the country ramped up imports of refined products, particularly low-sulfur fuel oil, to offset shortfalls in fuel supply for power generation until refineries were restored. In 2011, fuel oil imports surged to 102,000 bbl/d, rising from 58,000 bbl/d in 2010, while crude oil refining declined by 5.6% to 3.4 million bbl/d.

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## Natural gas

*Japan relies on LNG imports for virtually all of its natural gas demand and is the world's largest LNG importer.*

According to OGI, Japan had 738 billion cubic feet (Bcf) of proven natural gas reserves as of January 2013. Natural gas proven reserves have declined since 2007, when they measured 1.4 trillion cubic feet (Tcf). Most of Japan's natural gas fields are located along the western coastline.

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## Sector organization

Inpex and other companies created from the former Japan National Oil Company are the primary actors in Japan's domestic natural gas sector, as they are in the oil sector. Inpex, Mitsubishi, Mitsui, and various other Japanese companies are actively involved in domestic as well as overseas natural gas exploration and production. Osaka Gas, Tokyo Gas, and Toho Gas are Japan's largest retail natural gas companies, with a combined share of about 75% of the retail market. Japanese retail gas and electric companies are participating directly in overseas upstream LNG projects to assure reliability of supply.

Although Japan is a large natural gas consumer, it has a relatively limited domestic natural gas pipeline transmission system for a consumer of its size. This limited pipeline system is partly due to geographical constraints posed by the country's mountainous terrain, but it is also the result of previous regulations that limited investment in the sector. Reforms in 1995 and 1999 helped open the sector to greater competition; a number of new private companies entered the industry since the reforms were enacted.

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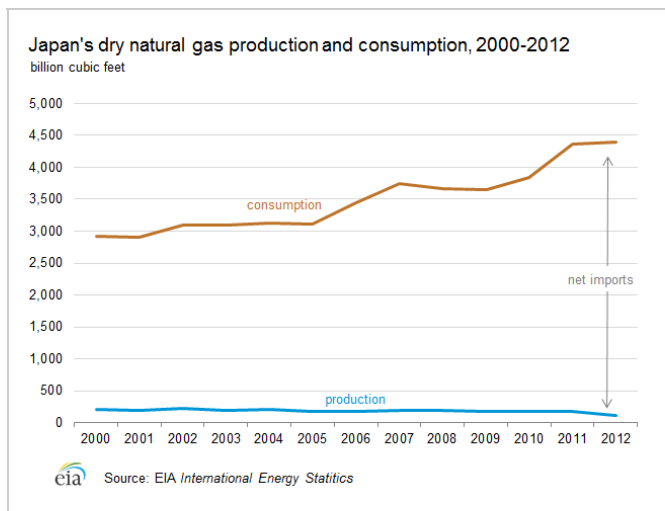
## Exploration and production

Japan's natural gas production has been low and flat for over a decade as a result of declining reserves. In 2012, production was 116 Bcf, a decline from an average of 185 Bcf over the past 10 years. Japan's largest natural gas field is the Minami-Nagaoka on the western coast of Honshu, which produces about 40% of Japan's domestic gas. Exploration



and development are still ongoing at that field, which Inpex discovered in 1979. The gas produced is transported via an 808-mile pipeline network that stretches across the region surrounding the Tokyo metropolitan area. Inpex is building an LNG terminal with a 73 Bcf/y capacity at Naoetsu port in Joetsu City, which will connect its domestic pipeline infrastructure with its overseas assets in Australia by 2014. Japex has been involved in locating new domestic reserves in the Niigata, Akita, and Hokkaido regions of Japan, targeting areas near existing oil and gas fields.

Japanese companies are using innovative methods to produce hydrocarbons and have discovered methane hydrates off the country's east coast. In March 2013, JOGMEC conducted the first successful testing of methane hydrates offshore and confirmed Japan's estimates of 40 Tcf of methane hydrates in the Nankai Trough on the southeast coast of the country. Japan hopes to begin production by 2018, although the high cost of such developments could push back production plans.



## Liquefied natural gas imports

*Japan consumed about 37% of global LNG in 2012, as the Fukushima disaster spurred greater demand for LNG in the power sector since 2011. A third of the country's LNG imports are from Southeast Asia, but Japan has a diverse portfolio of supply sources.*

Because of its limited natural gas resources, Japan must rely on imports to meet nearly all of its natural gas needs. Japan, the world's largest LNG importer, accounted for 37% of the global market share of LNG demand in 2012, rising from 33% in 2011. Japan began importing LNG from Alaska in 1969, making it a pioneer in the global LNG trade. Because of environmental concerns, the Japanese government has encouraged natural gas consumption in the country. The government has chosen LNG as its first fuel-of-choice for power generation to substitute for the lost nuclear generation.

In 2012, Japan consumed nearly 4.4 Tcf of natural gas, rising about 50% from the 2000 level. More than 95% of gas demand is met by LNG imports. As a result of the March 2011 earthquake, Japan's overall LNG imports rose about 24% between 2010 and 2012, from nearly 3.5 Tcf/y to 4.3 Tcf/y. The power sector is the largest consumer of gas, with 64% of the mix, followed by the industrial sector (21%), residential (9%), commercial (4%), and other sectors (2%) in 2012, according to PFC Energy and the Federation of Electric Power Companies of Japan (FEPC). Electric generation led to a larger slice of total gas demand following the loss of nuclear power capacity over two years ago when its share constituted about 57% of total gas consumption. LNG consumption by electric utilities rose by 33% from 2 Tcf in 2010 to a record-high of 2.7 Tcf in 2012. Tokyo Electric Power Company (TEPCO) is the largest electric utility and gas importer, holding 24% of the power generation market, according to the FEPC. The company purchased nearly a third of Japan's LNG imports in 2011. Tokyo Gas makes up over a third of the city gas share (industrial,

residential, and commercial sectors) and is the country's third largest LNG importer.

Japan has 30 operating LNG import terminals with a total gas send-out capacity of 8.6 Tcf/y, well in excess of demand. However, Japan is still constrained on how much LNG it can receive based on berthing, ship size, and other infrastructure limitations. Japan also has the largest regasification storage capacity in the world, holding 565 MMcf, which serves as a buffer during seasons of higher LNG demand. The majority of LNG terminals are located in the main population centers of Tokyo, Osaka, and Nagoya, near major urban and manufacturing hubs, and are owned by local power companies, either alone or in partnership with gas companies. These same companies own much of Japan's LNG tanker fleet. Five terminals now under construction are anticipated to come online by 2016, adding at least 350 Bcf/y of capacity.

Several factors favor the use of LNG over other fossil fuels and other sources to replace nuclear energy after the 2011 earthquake. Current government carbon-abatement policies and the government's pledge to lower GHG emissions support natural gas as the cleanest fossil fuel to replace capacity. Also, natural gas remains cheaper than oil in contrast to the situation following the last major earthquake in 2007, when fuel oil made the biggest gains from incremental demand. Destruction of coal-fired electric capacity was widespread in the area affected by the earthquake, restricting its use for two years following Fukushima.

Japan's higher gas demand for power and a tighter LNG global supply market over the past few years has led to a significant increase in LNG import prices, from \$9/MMBtu before the crisis to over \$16/MMBtu in 2012. Japan, along with other Asian LNG consumers, is negotiating lower prices for LNG contracts that historically have been linked to international crude oil prices. Oil prices in the past few years have remained at all-time high levels for Asian buyers, causing Japanese utilities, particularly those affected by the Fukushima accident, to incur serious expenses from higher gas and oil purchases, resulting in net revenue losses. In response to the rising fuel acquisition costs and attendant power price increases, METI is encouraging electric utilities to negotiate LNG prices to be equal to or lower than the previous deal before they can pass on higher fuel costs to their power consumers. Japanese companies are beginning to negotiate for LNG prices that move away from a tight link to crude oil prices to those that are based on lower U.S. gas market prices. Asian LNG prices traditionally have been tied to international oil prices, which have risen sharply since 2008. For instance, Kansai Electric reached an agreement with BP at the end of 2012 for a long-term contract based on a formula linked to the U.S. Henry Hub price.

After the Fukushima incident, Japan replaced lost nuclear capacity with more short-term and spot cargo LNG, which made up about 27% of total LNG imports in 2012 according to PFC Energy. As a result, Japanese companies signed 720 Bcf/y of LNG purchase agreements after 2011. Industry analysts project LNG imports to remain flat from 2012 to 2015. Reliance on LNG and other fossil fuels is contingent on how many nuclear facilities are able to return to operation in the next few years.

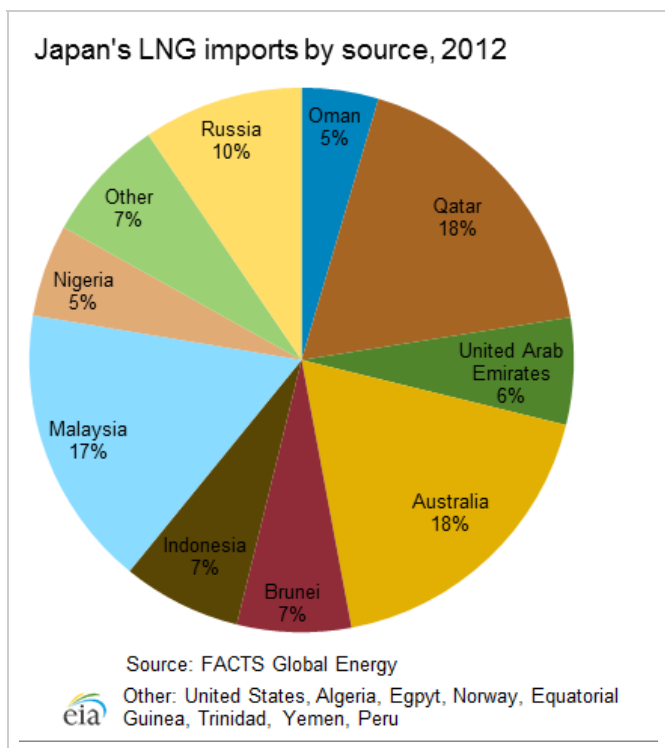
About a third of Japan's LNG imports originate from regional suppliers in Southeast Asia, although the country has a fairly balanced portfolio with no one supplier having a market share greater than roughly 20%. Japan's top five gas suppliers provided 70% of its natural gas imports in 2012. After the March 2011 disaster, several suppliers from Qatar, Russia, Malaysia, and Indonesia exported cargoes to Japan through swaps and diverted cargoes. Qatar, the world's largest supplier of LNG, overtook Indonesia and Malaysia in the past two years to become the second largest supplier to Japan in 2012 and provided most of the additional imports needed after the earthquake under short-term agreements. Japanese utility companies signed agreements with Qatargas at the end of 2011 to secure longer term LNG supply.

Supplies from traditional suppliers Malaysia and Indonesia are becoming more constrained, and Japan is seeking to diversify its contracts and investments in other LNG ventures. Australia surpassed Malaysia to become Japan's largest LNG supplier in 2012.

Japanese companies are investing in small equity stakes in Australia's liquefaction projects. Japanese electric and gas companies and trading houses have signed contracts with various large LNG projects in Australia, most significantly the Chevron-led Gorgon project, which will provide up to 2 Bcf/d of LNG to Asian markets by 2014. In 2012 Mitsui and Mitsubishi purchased a 15% stake in Australia's Browse LNG project that will supply at least 1.6 Bcf/d of natural gas from the Browse Basin in Western Australia. Japan began importing LNG from Russia's Sakhalin terminal in 2009, and the two countries are discussing ways to increase gas imports to Japan via a proposed pipeline or more LNG shipments.

Additional LNG supplies to Japan could stem from other new projects in Papua New Guinea or North America in the long term. Japan is in discussions with U.S. exporters for additional natural gas supply, although negotiations depend on approval of export licenses by the United States. In May 2013, the U.S. Department of Energy gave approval for its Freeport LNG terminal in the Gulf of Mexico to ship LNG to countries that do not hold free trade agreements (FTAs) with the United States. This decision allows Japanese utilities to formalize deals for LNG supply from the terminal's operator. Japan's Chubu Electric and Osaka Gas signed preliminary agreements to import over 100 Bcf/y each for 20 years from Freeport LNG starting in 2017, marking a potential reduction in the high LNG prices that Japan currently pays. Sumitomo, Japan's third largest trading house, holds an agreement to buy 110 Bcf/y for 20 years from Cove Point LNG on the U.S. East Coast which received approval to export to non-FTA countries in September 2013. Sumitomo intends to sell the supply to utilities Tokyo Gas and Kansai Electric. In May 2013, Mitsubishi and Mitsui, Japan's two largest trading companies, first ventured into the U.S. shale gas export market by purchasing a combined 33% equity share Cameron LNG project located in the Gulf of Mexico. The companies have agreements to purchase 384 Bcf/y, or two-thirds of the terminal's export capacity, expected to come online by 2017.

Japanese regulations permit individual utilities and natural gas distribution companies to sign LNG supply contracts with foreign sources, in addition to directly importing spot cargoes. The largest LNG supply agreements are held by Tokyo Gas, Osaka Gas, Chubu Electric, TEPCO, Kansai Electric, Kyushu Electric, and Tohoku Electric, primarily with countries in Southeast Asia and the Middle East. Many of Japan's existing LNG contracts that date from the 1970s and 1980s are expiring, forcing Japan to renegotiate term contracts or locate shorter-term supply. Some industry analysts suggest that this is driving Japanese firms' interest in acquiring equity stakes in foreign liquefaction projects, in an effort to guarantee future supply.



## Overseas exploration and production

Japanese companies, especially JX Nippon Group, Inpex, and Mitsubishi, have actively sought participation in overseas natural gas exploration and production projects that are typically linked to export facilities. The Japanese trading company, Mitsubishi, a key supplier to Japanese utilities, has owned capacity in liquefaction terminals, mostly in Southeast Asia, Australia, and Oman, for four decades. JX Nippon and Inpex are developing several production and export projects throughout Southeast Asia, Australia, and the UAE, and more recently, North America. In the past few years, Japanese utilities have also acquired small stakes in the upstream supply and operations of LNG projects in attempts to secure LNG contracts from emerging and growing LNG markets such as Australia, the United States, Canada, and Russia. JX Nippon plans to invest \$3.9 billion in oil and gas development projects over three years starting in 2013.

The recent opening of North American shale gas production and anticipated gas exports have attracted investment by Japanese companies in North American gas developments linked to planned LNG projects. Also, JOGMEC has been guaranteeing loans to back such projects that could help Japan diversify its gas sources and secure supply at lower prices. Mitsubishi and Mitsui's recent purchase of capacity in Cameron LNG was worth \$10 billion. Mitsubishi and Inpex are also participating in upstream ventures in the oil and shale gas developments in western Canada. Mitsui and Sumitomo are involved in large shale gas upstream ventures in the United States.

JOGMEC announced in 2013 that it will guarantee 75% of the bank loans to Japanese companies involved in developing LNG projects that help reduce Japan's import fuel cost. The projects must demonstrate lower rate compared to Japan's average LNG import costs from the previous year. METI is considering a similar program by providing a \$10 billion fund for loan guarantees to LNG projects.

## Japan's major upstream overseas natural gas projects

Country	Project	Japanese company equity	Project details
Australia	Ichthys LNG Project, Browse Basin, Western Australia	Inpex, 66% (also owns majority stakes in production licenses related to the LNG plant) Japanese electric utilities: 2.74%	Operational by 2017. Capacity: 400 Bcf/y, about 70% is reportedly intended for export to Japan.

Australia	Pluto LNG Project	Tokyo Gas 5% and Kansai Electric 5%	Purchase agreement for 182 Bcf/y of LNG for 15 years. The first train came online in early 2012, with estimated capacity of 200 Bcf/y.
Australia	Timor Sea Joint Petroleum Development Area, including Bayu-Undan gas and condensate field	Inpex, Tokyo Gas, and TEPCO, combined 20%	An LNG sales agreement was signed for annual supply of 146 Bcf/y, and the first shipment was in 2006.
Australia	Prelude LNG	Inpex 17.5% acquired from Shell in 2012.	The first floating LNG project, projected to come online in 2017.
Australia	Darwin LNG	Inpex 11.3%, TEPCO 6%, and Tokyo Gas 3%	Terminal capacity: 170 Bcf/y, which came online in 2006. TEPCO and Tokyo Gas have contracts totaling 146 Bcf/y for 17 years.
Australia	Wheatstone LNG	Japanese electric & gas utilities: 9.455%	430 Bcf/y expected online in 2016.
Australia	Browse LNG	Mitsubishi and Mitsui (MIMI Browse) 14.7% in LNG terminal. MIMI Browse owns stakes in gas and condensate fields: 16% in East Browse and 8% in West Browse.	Floating terminal being discussed; delays to development.
Canada	Canada LNG	Mitsubishi 20%	576 Bcf/y capacity
Canada	Pacific Northwest LNG	Japex 10%	Japex to purchase 58 Bcf/y of LNG.
Canada	Nexen shale gas projects	Inpex 40% in upstream development of Cordova, Horn River, and Liard basins.	Goal is to produce 1.25 Bcf/y from Horn River and Cordova projects.
Canada	Cutbank Ridge shale gas project in the Montney Ridge formation	Mitsubishi 40%	Partnered with Encana Corporation (Canada) in 2012
Canada	Cordova Embayment shale gas project	Mitsubishi 50%	Partnered with Penn West Energy (Canada) in 2010; anticipated production 0.5 Bcf/y by 2014.
Indonesia	Berau Block, Tangguh LNG Project	Joint venture of Inpex and Mitsubishi has a 22.9% interest in the Berau Block and a 16.3% interest in the Tangguh Project.	First cargo shipped in 2009. China, South Korea, and North America have long-term sales agreements for the 363 Bcf/y of production.
Indonesia	Senoro LNG plant, Sulawesi	Mitsubishi 45%	Mitsubishi is building a 97 Bcf/y LNG plant and will be the sole buyer of LNG from the plant, scheduled to come online in 2014.
Indonesia	Mahakam Block and Attaka Unit, Offshore Kalimantan Island	Inpex 50%	Fields began producing in 1972. Gas sent to Bontang liquefaction plant before being shipped to Japan. Inpex has a 20-year production contract through 2017, and is currently negotiating to extend it.
Indonesia	South Natuna Sea Block B	Inpex 35%	North Belut gas field started production 2009 at 97 Bcf/y; gas shipped to Malaysia under contract.
Indonesia	Abadi LNG Project	Inpex 60% of LNG terminal and 100% of Masela block.	Abadi field: 10 Tcf of gas reserves. Floating LNG plant with a 120 Bcf/y capacity, project expected to be online and shipping LNG to Japan and elsewhere by 2019.
Indonesia	Tangguh LNG Project (Berau Block)	Inpex and Mitsubishi JV 16.3% of LNG terminal and 22.9% of Berau block. JX Nippon and JOGMEC 12.2% of LNG terminal and 17.1% of Berau block.	Terminal began operating in 2009. PSC extended until 2035.
Malaysia	6 gas exploration and development projects	JX Nippon: Block SK10 (75%), Block SK8 (37.5%), Block SK333 (75%), Block PM308A (40%) and Deepwater Block R (37.5%), and Deepwater Block 2F (40%). JX Nippon: 10% interest in Tiga LNG terminal.	
Russia	Sakhalin-II	Mitsui and Mitsubishi combined 22.5%	Terminal began operating in 2009. About 60% of the project's LNG will be sold to Japan. Peak production

expected to be 468 Bcf/y.

United States	Gulf of Mexico oil and gas fields	Inpex 15% of Walker Ridge deep water exploration; other interests in shallow water blocks.	
United States	Marcellus shale gas assets in Pennsylvania	Mitsui acquired 32.5% of Anadarko Energy assets. Sumitomo acquired 30% of Rex Energy Corporation assets.	Peak production around 0.4 Bcf/y; production expected for 60 years.
United States	Barnett shale gas project in Texas	Sumitomo 12.5%	

Sources: Company web sites, PFC Energy, Platts, Rigzone

## Electricity

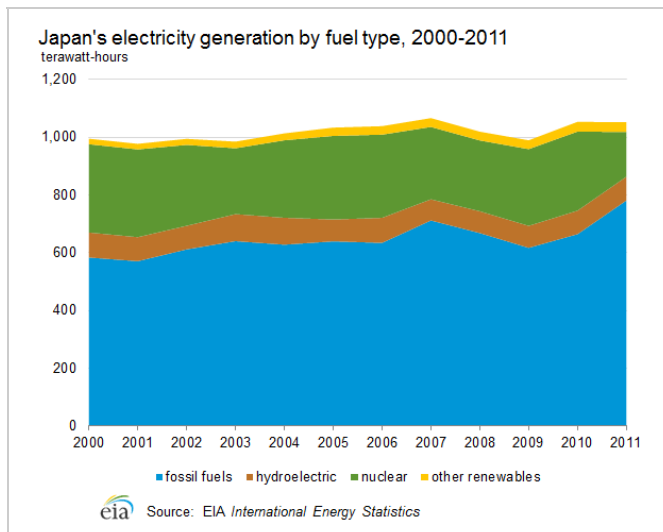
*Japan was the world's third largest producer of nuclear power after the United States and France before the Fukushima Daiichi nuclear power plant accident in March 2011. After the Fukushima disaster, the composition of fuel used for power generation shifted to fossil fuels, particularly LNG.*

Japan had 286 gigawatts (GW) of total installed electricity generating capacity in 2011, according to the Japan Electric Power Information Center, Incorporated (JEPIC). Fossil fuel-fired plants made up a bulk of this capacity, with over 185 GW (65%) of the total capacity. Nuclear capacity was 49 GW, holding 17% of the capacity, although installed capacity fell to 46 GW in 2012 after four reactors were decommissioned in the aftermath of Fukushima. Hydroelectric facilities held 17% of the capacity and have been a steady source of power supply for Japan for several years. The remaining capacity came from wind, solar, geothermal, and small biomass-fired plants.

Although Japan has the second highest demand for electricity in Asia, it has one of the lowest electricity demand growth rates in the region. In 2011, total generation was over 1,000 Terawatt-hour (TWh) and has remained at a similar level for over a decade. Since Japan depends highly on fuel imports to meet its generation needs, the country seeks to ensure an optimal combination of sources based on cost-efficiency, energy security, and environmental stability. Before most nuclear power generation was removed from service in 2011, Japan had one of the most balanced portfolios of power generation fuel sources of the world's major power consumers. Before the Fukushima disaster and the displacement of much of the nuclear-generated power, Japan was not reliant on any particular source for more than 30% of its total generation, according to the FEPC and IEA. Base load generation was met by non-pumped hydroelectric power (total share of hydroelectric generation was 7.4%), nuclear generation (26%), and geothermal sources (0.3%). LNG and coal were burned as the next sources of base load fuels, and each made up 27.4% of the generation mix according to the IEA data. Pumped hydroelectricity and oil provided peak-load generation. Oil consisted of 8.8% of the electricity generation mix. Other renewable sources include wind, solar, biomass, and waste, which in total were used for about 3% of power generation. Once Japan removed its nuclear generation capacity from operation, other fuels such as LNG and oil displaced it. This shift altered the generation portfolio mix. METI reports that LNG and oil shares rose to 48% and 16%, respectively, of total power generation, as nuclear power's share fell to 2% in 2012.

The Japanese government and electric utilities have taken several steps to ensure power supply meets demand following the Fukushima crisis. Some of these measures for power plants using fossil fuels include restoring some of the disaster-affected plants, relaxing regulations on inspections, and restarting mothballed oil-fueled generation units. Also, the government promoted power restrictions for consumers in the disaster-affected areas in 2011 and 2012, invoking a 15% power reduction on end users of Kansai Electric Power Company (KEPCO) during the summer of 2012 and encouraging other demand-side measures especially during the peak summer seasons. As power generation from fossil

fuel sources increases and power demand moderates, there is less need for electricity rationing.



## Sector organization

Japan's electricity industry is dominated by 10 privately-owned, integrated power companies that act as regional monopolies, accounting for about 80% of the country's total installed generating capacity. The remaining electricity is generated by industrial facilities or independent power producers. The largest power company is TEPCO, which accounted for 24% of total power generation in the country in 2011. These companies also control the country's regional transmission and distribution infrastructure. Japan's electricity policies are managed by the Agency for Natural Resources and Environment, part of METI. Japan has two power grids with limited interconnections.

Other significant operators in the electricity market are the Japan Atomic Power Company, the first Japanese company to build a nuclear reactor in 1960, and the Electric Power Development Company (J-Power), formerly a state-owned enterprise that was privatized in 2004. The Japan Atomic Power Company operates four nuclear power plants with 2.6 GW total and sells electricity to the local power companies. J-Power operates 16 GW of hydroelectric and fossil fuel-fired power plants. It has also been involved in consulting services for electricity production and environmental protection in 63 countries, mainly in the developing world, since 1960.

## Electricity price reform

Following market deregulation of Japan's electricity sector that began in 1995, the current Japanese government under Prime Minister Abe is attempting to allow electricity end users to choose their power generation suppliers by 2020. Essentially, the electricity reforms are aimed at greater competition and lower electricity prices for consumers based on better power sector operations and investments. Abe's cabinet approved a plan to unbundle generation, transmission, and distribution of the country's 10 regional monopolies in April 2013. The Cabinet intends to submit a series of bills to the legislative branch by 2015 to accomplish this unbundling.

Because of the soaring fossil fuel costs, Japan's electric utilities have sought to increase the electricity tariffs paid by end users to help cover their losses. Since July 2012, METI has approved tariff raises between 7% and 11% for six utilities (TEPCO, Kansai Electric, Kyushu Electric, Hokkaido Electric, Shikoku Electric, and Tohoku Electric).

## Electricity generation

*As of late 2013, all of Japan's nuclear power generation capacity was removed from service. Oil and natural gas replaced all of the lost nuclear generation in 2011 and 2012. As nuclear capacity resumes operation following government approval of facilities, Japan anticipates reducing the current share of fossil fuel generation.*

### *Fossil fuels*

Japan had about 185 GW of installed fossil fuel-fired electric generating capacity in 2011 according to the Japan Electric Power Information Center, or about 65% of the total capacity. EIA reports that electricity generation of fossil fuels accounted for 781 TWh in 2011, representing about 74% of the total generation, the highest share in over two decades. This share rose to an estimated 89% in 2012 in the wake of the Fukushima disaster when electric utilities turned to fossil fuel use in power generation according to METI. Utilization rates in Japan's fossil fuel-fired capacity had been relatively low when the country relied on its nuclear capacity. According to Japan Electric Power Information Center, there are currently 65 major thermal power plants owned by electric utilities, and 5 more plants are under construction: 4 using LNG by 2016 and 1 using coal for generation by 2023. The country's aging oil-fired power plants are used primarily to meet peak demand. Some facilities have dual-fuel (coal/oil or natural gas/oil) capabilities to provide more flexibility of supply and have been particularly useful during the loss of nuclear generation capacity.

Coal, typically used as a base load source for power generation, remains an important fuel source and accounted for nearly 27% of Japan's electric capacity in 2010 according to the FEPC and IEA. Domestic coal production ended by 2002, and Japan began importing all of its coal, primarily from Australia. Japan imported 194 million short tons of coal in 2011, a slight decline from 206 million short tons imported in 2010. Japan had been the largest global coal importer for three decades until 2012 when China surpassed Japan by a wide margin according to World Coal Association estimates. Coal has remained a base load fuel for power in Japan, and coal consumption has hovered around 200 million short tons since 2004. Several coal-fired plants experienced significant damage following the 2011 earthquake because they were located near Fukushima. Therefore, coal use was largely unchanged in 2011 and 2012 while the country heavily relied on natural gas and oil for power generation to replace lost nuclear capacity. Two more coal-fired power plants with a combined capacity of 1.6 GW came online in northern Japan in the first part of 2013. Also, 2 GW of capacity at the Haramachi plant came back online in 2013 after being decommissioned following damage in the 2011 earthquake. Japan is encouraging utilities to build more coal-fired capacity in the aftermath of the earthquake by lessening the environmental regulations for construction and for burning coal. At the same time, new, clean coal technologies are being pursued in the power sector in efforts to meet environmental targets. Coal consumption rose in the second and third quarters of 2013 by about 20% from the same period a year ago according to PFC Energy. Coal is expected to displace some of the more expensive oil-fired generation used for power, according to the Petroleum Association of Japan.

Natural gas plays a significant role in the power sector and made up over 27% of the electric generation in 2010 before the Fukushima disaster according to METI. Post-Fukushima, a majority of the lost nuclear generation was substituted by natural gas-fired power plants. The number of natural gas-fired power stations is increasing in Japan, with at least 7 GW of capacity from combined cycle units expected to come online by 2016. Capacity utilization in gas-fired power facilities in Japan's top 10 regional utilities was 66% in June 2013 according to the government. Increasing LNG use in the long-run will be determined by the speed of new gas-fired capacity and LNG tanker ships coming online and the ability of some nuclear capacity to return to operation. The government has plans to construct more gas-fired power generators, and currently, there are three proposed gas-fired power plants with 3.4 GW of capacity scheduled to come online by 2016. The lead-time on greenfield plants is generally 7 to 10 years mainly due to environmental permitting. However, TEPCO and Tohoku Electric Power, utilities that suffered damage to their gas-fired plants in the earthquake zone, were temporarily exempted from these environmental requirements.



Before the 2011 earthquake, Japanese utilities began removing oil-fired generation capacity because of its higher operational costs. Capacity utilization at oil-fired facilities was around 30% in 2009. Power companies have plenty of room to increase burn of crude oil and fuel oil, and some utilities have brought back mothballed facilities to compensate for lost nuclear power. Direct crude oil burned for power skyrocketed from 85,000 bbl/d in 2010 to 281,000 bbl/d in 2012 according to FACTS Global Energy, a 230% increase. Likewise, heavy fuel oil used for power generation grew from 100,000 bbl/d in 2010 to 280,000 bbl/d in 2012, an increase of 180%. The power sector's incremental demand for both crude oil and fuel oil spiked to around 400,000 bbl/d in the first few months of 2012. However, total oil demand for power declined in the first half of 2013 from the prior year's level. Lower power demand and the start of new coal facilities in 2013 are allowing utilities to reduce their oil consumption and lower generating costs.

### *Nuclear*

Before the Fukushima accident, Japan ranked as the third-largest nuclear power generator in the world behind the United States and France. However, the country has lost all of its nuclear generation capacity as its facilities have been removed from service over the past two years because of earthquake damage or for regular maintenance. Japan currently has 50 nuclear reactors at 17 power plants with a total installed generating capacity of 46 GW, down from 54 reactors with 49 GW of capacity in 2010. Over 10 GW of nuclear capacity at the Fukushima, Onagawa, and Tokai facilities ceased operations immediately following the earthquake and tsunami, and some of the reactors are permanently damaged from emergency seawater pumping efforts and not scheduled to return to service. The government officially decommissioned 4 reactors with a capacity of 3 GW at the Fukushima Daiichi nuclear plant. Prime Minister Abe also called for the other 2 reactors at Fukushima Daiichi to be decommissioned. Below is a map of Japan's key nuclear facilities and the location of the 2011 earthquake.

General maintenance standards in Japan require facilities to come offline every 13 months for inspections. Following the Fukushima disaster, the Japanese government required facilities to pass stress tests as well as local government approval. As reactors were removed from operation, they remained offline. By May 2012, Japan had no nuclear generation for the first time in over 40 years. The government returned two of the reactors, Kansai Electric's Ohi #3 and Ohi #4, to service in July 2012, leaving Japan with only 2.4 GW of capacity for slightly more than a year. These two reactors were again removed from service in September 2013, leaving Japan with no operational nuclear capacity for a second time. EIA estimates that Japan produced 155 TWh of nuclear-generated electricity in 2011, down from 274 TWh in 2010.

The 2010 Energy Plan called for at least 12 new nuclear reactors to be constructed by 2020 and the nuclear share of electric generation to increase to a 50% share by 2030 as the country attempts to reduce greenhouse gas emissions. However, the Fukushima catastrophe created greater public concerns and revealed potential dangers of an aggressive nuclear policy. The previous government led by former Prime Minister Noda in 2012 pledged a no-nuclear policy that encountered push-back from the business sector and the current administration headed by Prime Minister Abe, who supports nuclear power providing at least 15% of power generation. Prime Minister Abe and industrial interests in Japan favor re-commissioning nuclear power to lower energy costs. However, they are balancing safety concerns and resistance from anti-nuclear government factions and the public. The government hopes to draft a revised energy policy by the end of 2013 to increase the role of LNG and renewable fuels and include some nuclear capacity.

Japan established the Nuclear Regulatory Authority (NRA) in September 2012 to replace two other nuclear agencies, the Nuclear Safety Commission and METI's Nuclear and Industrial Safety Agency. The NRA was established to provide a more independent assessment of nuclear safety. The NRA adopted more stringent nuclear safety guidelines and procedures in July 2013 and is in charge of their enforcement. All nuclear facilities must submit applications to restart operations to the NRA, and the government estimates taking up to six months to review each application. These safety guidelines are to ensure facilities

can withstand all natural disasters and require reactors to be located away from active earthquake fault lines. The guidelines require installation of larger seawalls, air vents, and safety control rooms. Also, the new standards include de-commissioning any reactors older than 40 years, with a possible 20-year extension, to improve safety. Ultimately, this standard contributes to a long-term decline in nuclear capacity unless new reactors are constructed. Utilities anticipate cost increases to comply with the safety standards for upgrading a facility before it is approved. Six Japanese utilities announced in mid-2013 that they plan to restart 20 nuclear reactors by 2015. As of September 2013, 4 companies had submitted applications for 12 nuclear reactors, with a total capacity of 11.2 GW. Also, there are currently two nuclear plants with 2.7 GW of capacity under construction and originally scheduled to be online by 2014. However, these plants must be approved under the new standards before operating. Industry analysts expect a few reactors to return to operation in the first quarter of 2014.

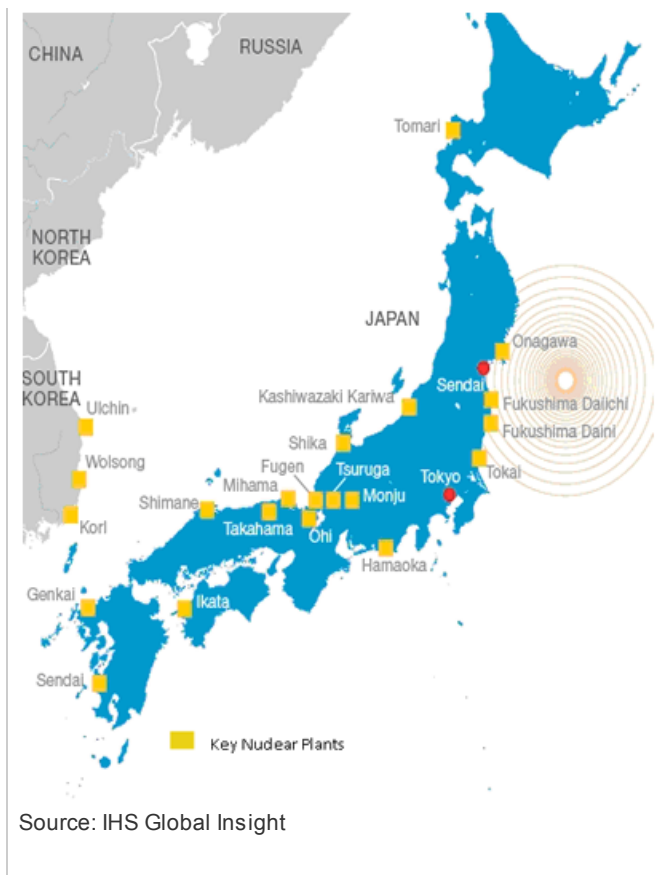
Japan has a full nuclear fuel cycle, including enrichment and reprocessing of used fuel. Japan has promoted nuclear electricity over the years as a means of diversifying its energy sources and reducing carbon emissions, emphasizing safety and reliability. According to the FEPC, nuclear power has made a great contribution to Japan's energy security by reducing its energy imports and CO<sub>2</sub> emissions. Before nuclear power was removed, the intensity of Japan's CO<sub>2</sub> emissions (emission per unit of electricity consumption) decreased by about 16% from 1990 levels. In 2012, CO<sub>2</sub> emissions intensity increased by 14% from 1990 levels.

#### *Hydroelectricity and other renewables*

Japan's installed hydroelectric generating capacity was 48 GW in 2011, accounting for about 16% of total electricity capacity. About half of this capacity is pumped storage. Also, roughly half of the installed capacity consists of large plants. One of TEPCO's facilities at the Kannagawa plant came online in 2012, and another 3.3 GW is expected to be online by 2022. Like nuclear power, hydropower is a source for base load generation in Japan because of the low generation costs and stable supply. Hydroelectric generation was 83 TWh in 2011, making up about 8% of total net generation mix. The Japanese government has been investing in small hydropower projects to serve local communities, although the potential for growth of hydroelectricity in Japan is limited.

As part of the revised energy policy plan, Japan is trying to encourage a greater use of renewable energy, from sources such as solar, wind, geothermal, and biomass for power generation. Renewable energy apart from nuclear and hydroelectricity made up about 2% of Japan's total energy consumption and about 3% or 34 TWh of the country's total electricity generation in 2011. The Japanese legislature approved generous feed-in tariffs for renewable sources in July 2012, compelling electric utilities to purchase electricity generated by renewable fuel sources, except for nuclear, at fixed prices. The costs are shared by government subsidies and the end users. The feed-in tariffs spurred development of nearly 1.4 GW of renewable energy capacity that was installed between July 2012 and February 2013. Biomass made up the largest portion (68%) of generation from other renewable sources in 2011. Wind, solar, and tidal power are being actively pursued in the country and installed capacity from these sources increased in recent years to over 4 GW in 2011, up from 0.8 GW in 2004. However, these sources continue to account for a relatively small share of generation at this time. Most of the growth of renewables in the past year has occurred in solar energy as a result of heavy investment for large-scale PV units. METI is considering 21 additional geothermal projects in addition to the 17 facilities containing 520 MW of capacity that currently exist. The potential for geothermal power is significant because the country has the third largest reserves in the world.

**Japan's key nuclear power plants in relation to the Fukushima earthquake**



## Notes

- Data presented in the text are the most recent available as of October 29, 2013.
- Data are EIA estimates unless otherwise noted.

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