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India's Natural Gas: A Small Part of the Energy Mix

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Summary

India's population is expected to surpass China as the world's largest by 2022, reaching approximately 1.4 billion people, creating greater demand for energy. India has the potential to be a much larger producer and consumer of natural gas. Competing political and economic factors have limited the government's effectiveness in changing the country's energy mix, which is heavily weighted toward coal and oil. Continually beset by high-profile environmental issues such as major air pollution and contaminated water supplies due to their reliance on coal and oil, the Indian government is now setting policies to increase lower-carbon energy use, but whether the government can overcome the economic and political hurdles remains a question. The portion of natural gas in India's energy mix, 7%, remains small compared to that of the United States, though it is comparable to similar emerging economies like Brazil, China, and South Africa. Despite India's intentions to double the proportion of natural gas consumption by 2022, achieving this goal would require major upstream, midstream, and downstream investments as well as the continued political will to enact the necessary changes to decrease reliance on coal and oil.

India's natural gas plans have implications for a number of issues in which Congress has expressed an interest. Those issues include the prospects for U.S. hydrocarbon exports, U.S. energy companies' investments, Indian investments in U.S. natural gas production, India's ability to meet its international commitments to reduce greenhouse gas emissions in order to combat climate change, and India's plans for integrating itself into the growing South Asian energy market. In the mid-2000s, Members of both houses of Congress expressed interest to formalize closer energy ties between the United States and India, and legislation was introduced. The legislation was not enacted into law; however, the executive branch has implemented programs to further improve the energy partnership between the two nations.

India's central government manages its energy sector mainly via four ministries: Power; Coal; Petroleum and Natural Gas; and New and Renewable Energy; along with the Department of Atomic Energy. Decades ago the Government of India created entities designated "Public Sector Undertakings (PSUs)" to ensure complete control of the petroleum logistics chain. These PSUs have become some of India's largest companies. The Oil and Natural Gas Corporation (ONGC), Gas Authority of India Limited (GAIL), and Indian Oil Corporation Limited are consistently ranked among the world's bigger energy companies. The PSUs are India's primary international and domestic energy actors, although some private sector companies have become key players as well. However, government control of the energy sector has stymied India's development of its domestic resources and hindered its efforts internationally. In the past decade, India has incentivized foreign access to its upstream sector as a way to increase domestic production. Some of India's energy companies are also investing more in U.S. energy projects and have signed contracts to import U.S. liquefied natural gas (LNG).

Due to limited drilling activity and available information, how much technically recoverable natural gas exists in India is unclear. However, India's current assessment of total reserves—resources that are economically and technically viable under existing market conditions—are estimated to represent less than 1% of the global natural gas total. As India attempts to shift away from coal and oil over the coming decades, natural gas production, especially from offshore resources, is seen as a way to increase domestic supply. Combined with improving infrastructure for imported LNG, India could become a bigger natural gas consumer in the future.

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Introduction

As India's economy continues to grow, its energy needs, including for natural gas, will likely grow as well. India's economy is expected to grow fivefold by 2040, according to Prime Minister Narendra Modi.¹ Its population is expected to surpass China as the world's largest by 2022, reaching approximately 1.4 billion people, creating greater demand for energy. In 2015 India accounted for 5.3% of global primary energy consumption, while China was the largest consumer with 22.9%.² Overall, India imports almost three-quarters of its energy needs, making it highly dependent on other countries. The Organization for Economic Co-operation and Development (OECD) believes India will remain the fastest growing G20 economy in 2017-2018, with an annual projected growth rate of 7.5%.³ By 2050, India has the potential to overtake the United States as the world's second largest economy in terms of purchasing power parity (PPP).⁴

Natural gas makes up 7% of India's total energy consumption, well behind coal and oil. Similarly, natural gas accounts for 6% of China's energy mix, though China uses almost four times as much natural gas as India (see **Figure 1**). With an eye on increasing this percentage, India is instituting a number of policy initiatives like the Hydrocarbon Exploration and Licensing Policy (HELP) and major infrastructure investments such as expanding domestic gas pipelines and liquefied natural gas (LNG) import terminals. If global natural gas prices continue to be relatively low, natural gas consumption in India will likely grow in the coming decade. However, these changes likely will take significant investment and commitment from the Indian government to reach fruition.

India's natural gas demand is forecasted to grow at about 6% annually over the next five years, according to the International Energy Agency (IEA) due to increases in domestic production and falling LNG import prices.⁵ India is continuing to build its energy infrastructure for natural gas, which had previously been almost exclusively configured for coal and oil, to reverse the recent declines in natural gas consumption. In 2015, India's natural gas consumption declined almost 18% since its peak in 2011, two-thirds of which occurred between 2012 and 2013, in part because of large drops in domestic production and an inability to compensate the drop in domestic production with LNG imports. The Government of India (GoI) has indicated it will change this in the short term, but the GoI's commitment and resources necessary for these changes are uncertain.

¹ "India's Economy Expected to Grow Fivefold by 2040: PM Narendra Modi," *Economic Times*, December 5, 2016.

² BP, *BP Statistical Review 2016*, "India's Energy Market in 2015, 2016," <http://www.bp.com/content/dam/bp/pdf/energy-economics/statistical-review-2016/bp-statistical-review-of-world-energy-2016-india-insights.pdf>.

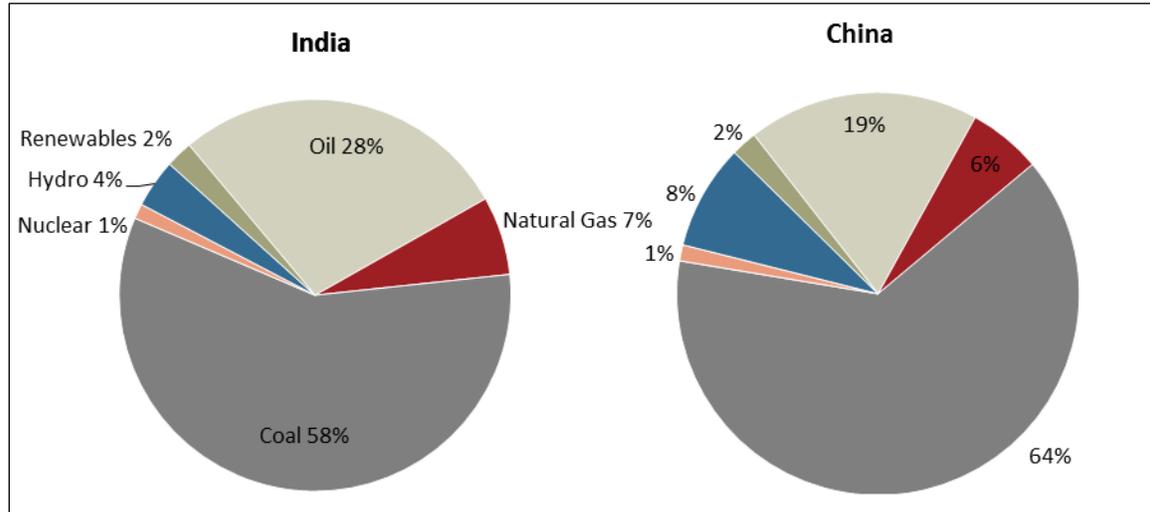
³ OECD, *Developments in Individual OECD and Selected Non-Member Economies*, India-Economic forecast summary, November 2016, <http://www.oecd.org/economy/india-economic-forecast-summary.htm>.

⁴ PricewaterhouseCoopers LLP, *The World in 2050*, February 2015, p. 2, <http://www.pwc.com/gx/en/issues/the-economy/assets/world-in-2050-february-2015.pdf>. Purchasing Power Parity (PPP) is an economic measure of a country's productivity and standard of living.

⁵ International Energy Agency, Gas, Coal and Power Division, *Gas Medium-Term Market Report 2016*, Paris, 2016, p. 11.

Figure I. India and China Primary Energy Consumption, 2015

India = 701 MTOE, China = 3,014 MTOE

**Source:** BP Statistical Review of World Energy, 2016.**Notes:** Units = million tonnes of oil equivalent (MTOE).

India has not been a major factor in global natural gas markets as a producer, but is growing as an importer. India is the 27th largest natural gas producer in the world, accounting for less than 1% of global production, according to the *BP Statistical Review of World Energy*.⁶ In 2015, India's natural gas production fell by 3.8%, its fifth straight year of decline. This has been due to a variety of factors, including difficult geology, cheaper alternative energy sources, and lagging infrastructure development.

In 2015, India was the 14th largest consumer of natural gas in the world.⁷ This consumption comes from domestically-produced and imported LNG, which has been growing. India is currently the 5th largest importer of LNG in the world and is likely to grow as more LNG import terminals are built.

The United States has viewed India as an important strategic partner in advancing common interests in the Asia-Pacific region and globally. India is the dominant actor in South Asia and viewed by many analysts as a counterweight to China's growing influence.⁸ In 2015, India was the United States' 10th largest trading partner, comprising \$39 billion in U.S. exports and \$69 billion in U.S. imports. The two nations have also pledged to increase their annual trade about five-fold to \$500 billion by 2024. India's relationship with the United States on energy issues, though not significant to the broader energy market, has grown closer in recent years. The United States has expanded technical assistance programs in order to help India meet its carbon emission reduction goals. Indian energy companies have also signed contracts to import U.S. LNG.

⁶ BP, *BP Statistical Review of World Energy*, June 2016, p. 22.

⁷ BP, *BP Statistical Review of World Energy*, June 2016, p. 23.

⁸ See, for example, Harsh Pant and Yogesh Joshi, *The US Pivot and Indian Foreign Policy* (Palgrave, 2016), and Amitabh Mattoo, "Shadow of the Dragon: Indo-US Relations and China," in Gary Bertsch, Seema Gahlaut, and Anupam Srivastava, eds., *Engaging India: US Strategic Relations with the World's Largest Democracy* (Routledge, 1999).

While he was chief minister of Gujarat, India's most western state and an important natural gas producing area, current Prime Minister Narendra Modi took a strong interest in modernizing his state's energy supply, eventually bringing electricity to all of Gujarat's villages.⁹ Modi's party came into office with the first parliamentary majority in 30 years and has already enacted several policy changes intended to provide India with a reliable, secure, and diverse energy supply. For example, the Modi administration has loosened offshore exploration regulations, as well as instituted a policy to provide fertilizer plants with subsidies for purchasing natural gas more affordably.

Issues for Congress

Some Members of Congress have been interested in enhancing energy cooperation between the United States and India since the mid-2000s. Bills were introduced in both houses that would support closer energy ties between the two countries; however, none were enacted into law. India's natural gas plans have implications for a number of issues in which Congress has expressed an interest. Those issues include the following:

- Prospects for U.S. natural gas exports;¹⁰
- Prospects for U.S. energy companies' investments in India;
- Indian investment in the U.S. energy sector;
- India's ability to meet its global commitments to reduce greenhouse gas emissions in order to combat climate change;¹¹
- India's ability to reduce its chronic air pollution problems, especially in New Delhi where recently smog has reached sixteen times levels deemed safe;¹² and
- India's political and economic relationships with regions such as the Middle East, a major supplier of LNG, and Central Asia, a potential supplier of natural gas via pipelines.

Background: Government Control of Natural Gas

For years, oil and natural gas exploration in India was carried out only by state-owned companies like Oil and Natural Gas Corporation (ONGC) and Oil India Limited (OIL). By the 1980s, the GoI recognized the need for additional exploration, and began allowing foreign and domestic private companies through joint ventures and foreign direct investment to explore for oil and natural gas.

In order to attract more foreign direct investment, the GoI liberalized the upstream and downstream domestic gas industries in a phased manner with the launching of the New

⁹ Modi became Prime Minister in 2014 after the main opposition Bharatiya Janata Party (BJP or "Indian Peoples Party") won a historic victory. He is a self-avowed Hindu nationalist, who arose from humble social circumstances, and ran a campaign emphasizing economic development and good governance, among other issues.

¹⁰ For additional information on LNG exports see CRS Report R42074, *U.S. Natural Gas Exports: New Opportunities, Uncertain Outcomes*, by Michael Ratner et al.

¹¹ In June, 2016 Indian President Narendra Modi addressed the U.S. Congress and committed to enhance foreign investment in India and reinforced his commitment to meet carbon reduction goals.

¹² Michael Safi, "Indian Government Declares Delhi Air Pollution an Emergency," *The Guardian*, November 6, 2016.

Exploration Licensing Policy (NELP) in 1999.¹³ With India's energy use expected to double by 2040,¹⁴ in 2016 the Modi government introduced the Hydrocarbon Exploration and Licensing Policy (HELP), a new scheme intended to enhance domestic oil and gas production, entice major investment into the sector, and to increase employment.¹⁵ HELP instituted a new investment-friendly policy, including for foreign companies, to provide uniform exploration and production standards for all domestic oil and natural gas production.¹⁶ Previously, the GoI's heavy-handed approach to energy investments led to frequent delays and disputes with foreign companies. Under HELP, there is to be a new streamlined revenue sharing model, which will allow the offshore energy producing companies to market and sell their products with minimal government interference. As of January 2017, however, the first auction of oil and gas blocks under HELP has yet to take place.¹⁷

Key Indian Government Agencies

Despite recent market-oriented reforms, additional energy policy guidance is still needed from the highest levels of the Indian government.¹⁸ This guidance mainly consists of schemes to improve access to and encourage consumption of natural gas. The GoI oversees four main ministries devoted to energy production, along with the Department of Atomic Energy. Natural gas production and distribution is regulated mainly through the Ministry of Petroleum and Natural Gas (MoPNG).¹⁹ Within the MoPNG are:

- 11 public sector undertakings (PSUs) focused on petroleum and natural gas;²⁰
- the Directorate General of Hydrocarbons (DGH), which largely manages the awarding and implementation of the New Exploration Licensing Policy (NELP) scheme;²¹
- the Petroleum Planning and Analysis Cell, which is responsible for periodically revising natural gas prices under the guidelines set in 2014,²² and
- the Petroleum Conservation Research Association, which promotes policies and strategies aimed at reducing India's dependence on oil.²³

¹³ Directorate General of Hydrocarbons, *NELP Rounds*, <http://www.dghindia.org/index.php/page?pageId=59&name=INDIA%E2%80%99S%20E%20and%20P%20REGIME>.

¹⁴ International Energy Agency, *India Energy Outlook 2015*, World Energy Outlook Special Report, Paris, 2015, p. 56, https://www.iea.org/publications/freepublications/publication/IndiaEnergyOutlook_WEO2015.pdf.

¹⁵ PMIndia, "Hydrocarbon Exploration and Licensing Policy (HELP)," press release, March 10, 2016, http://www.pmindia.gov.in/en/news_updates/hydrocarbon-exploration-and-licensing-policy-help/.

¹⁶ PTI, "PM asks Indian Energy Companies to Become MNCs," *The Economic Times*, December 5, 2016.

¹⁷ "Budget 2017: Should Take the Right Steps to Rejuvenate Energy Sector," *MoneyControl*, January 25, 2017. http://www.moneycontrol.com/news/tax/budget-2017-should-takeright-steps-to-rejuvenate-energy-sector_8344201.html.

¹⁸ International Energy Agency, *India Energy Outlook 2015*, World Energy Outlook Special Report, Paris, 2015, pp. 8-9, https://www.iea.org/publications/freepublications/publication/IndiaEnergyOutlook_WEO2015.pdf.

¹⁹ Ali Al-Saffar, Marco Baroni, and Christian Besson, et al., *India Energy Outlook*, International Energy Agency, World Energy Outlook Special Report, Paris, 2015, p. 42, http://www.worldenergyoutlook.org/media/weowebiste/2015/IndiaEnergyOutlook_WEO2015.pdf.

²⁰ A list of these PSUs can be found at <http://www.petroleum.nic.in/affpsus.htm>.

²¹ Additional information can be found at <http://dghindia.org/>.

²² Additional information can be found at <http://petroleum.nic.in/docs/NewNaturalGasPricingGuidelines.pdf>.

²³ Additional information can be found at <http://www.pkra.org/pages/display/15-about-pkra>.

India's Major Energy Companies

India's domestic natural gas production and distribution industry operates through a mix of state-owned and private companies. India's two main national companies, ONGC and Oil India Limited (OIL), were responsible for three-fourths of India's total domestic natural gas production in 2015-2016.²⁴ In 2016, the industry newsletter *Platt's* ranked ONGC as the 20th and OIL the 201st largest oil and gas companies in the world.²⁵ Additionally, *Petroleum Intelligence Weekly*, another industry publication, ranked ONGC 22nd and 25th for natural gas production and reserves in the world, respectively. A third state-run company, Gas Authority of India Limited (GAIL), is India's largest commercial marketer and domestic distributor of natural gas.²⁶

The GoI has also promoted joint ventures. One of these, Petronet, is India's largest LNG importer. Petronet was formed by GAIL, ONGC, Indian Oil Corporation Limited (IOC), and Bharat Petroleum Corporation Limited (BPCL). Petronet is now publicly traded on the National Stock Exchange of India and is a major player in India's growing LNG market, operating two of India's largest LNG import terminals. Additionally, in early 2017, GAIL agreed to buy 3.5 million tons of LNG, or about 170 million cubic feet (5 billion cubic meters (BCM)), per year at a fixed fee of \$3/million British thermal unit (mmBtu) from Cheniere's Sabine Pass LNG plant in Louisiana's Gulf Coast region.²⁷

India also now has a number of large private companies that have expanded into natural gas production and development. Reliance Industries is a Fortune Global 500 company, and is the largest private sector company in India, with annual revenues over \$34 billion. The company has made major investments in U.S. shale gas deposit projects with Pioneer Natural Resources in Texas and with Chevron in Pennsylvania.²⁸

12th Five-Year Plan (2012-2017)

In five-year increments, the GoI lays out its plans and goals for key economic sectors, including for energy. During the period of the 12th Five-Year Plan, 2012-2017, India planned to continue relying on coal for the majority of its fuel to supply electrical power. According to the Plan, coal would supply the energy for over 80% of the electrical capacity added during the Plan's period. The GoI planned to add 28 times more coal-fired capacity than that for gas. While India intends to lessen its dependence on coal in favor of nuclear and renewables after 2030, according to its 12th five-year plan, coal will likely continue to be the primary energy source for electricity generation. By comparison, the Plan projected only a marginal role for natural gas in meeting India's energy demands.

In the Plan, the GoI recognized the need for it to play less of a direct role in oil and natural gas "contract administration," as well as "capex/pricing decisions."²⁹ This recognition led to the new Hydrocarbon Exploration and Licensing Policy (HELP) unveiled in late 2016. As a foreign

²⁴ Ministry of Petroleum and Natural Gas (MoPNG) of India, "Petroleum and Natural Gas Statistics 2015-16," <http://petroleum.nic.in/docs/pngstat.pdf>.

²⁵ "2016 Top 250 Global Energy Company Rankings," *Platt's*, 2016.

²⁶ China's two major oil and gas companies, CNPC and CNOOC are ranked 13th and 22nd, respectively.

²⁷ "Cheniere Executes First Tolling Contract," *LNG Intelligence*, January 6, 2017.

²⁸ George Smith Alexander, Abishek Shanker, and Debjit Chakraborty, "Billionaire Ambani Said to Weigh Sale of U.S. Shale Holdings," *Bloomberg*, July 28, 2015.

²⁹ Government of India, Economic Sectors, Planning Commission, *Twelfth Five Year Plan 2012-17*, New Delhi, 2012, p. 181, http://planningcommission.gov.in/plans/planrel/12thplan/pdf/12fyp_vol2.pdf.

investment policy, HELP is intended to make it easier and more profitable for foreign energy companies to extract India's offshore oil and natural gas resources. The first round of bidding on offshore drilling blocks is underway and expected to be finalized in early 2017.

India's 13th Five-Year Plan is expected to be published sometime in 2017. It is unclear if the government intends to change course and place greater emphasis on natural gas in India's energy mix or not.

U.S.-India Cooperation on Energy

India-U.S. energy relations have steadily grown stronger in recent years. In 2009, the United States and India launched the Partnership to Advance Clean Energy (PACE) in order to accelerate low carbon growth in India.³⁰ As part of this program, the U.S. Department of Energy committed \$25 million from 2011-2016 to support the U.S.-India Joint Clean Energy Research and Development Center (JCERDC).³¹ The Indian Ministry of Science and Technology also pledged to provide an additional \$50 million in funding to support JCERDC research in India. PACE was strengthened and expanded in 2015 during a meeting between Indian Prime Minister Modi and President Obama and in May 2016 the two governments announced the first nine recipients of off-grid innovation funding.³²

In 2010, the Indian Ministry of Petroleum and Natural Gas (MoPNG) and the U.S. Department of State signed a memorandum of understanding (MOU) to expand cooperation on the development and extraction of India's shale gas resources.³³ In 2012, through the State Department's Unconventional Gas Technical Engagement Program, the United States agreed to share experience and best practices to establish the necessary environmental protection and regulatory framework as India explores its own shale gas potential.³⁴

A 2016 research partnership between the GoI, the Government of Japan, and the U.S. Geological Survey discovered highly enriched natural gas hydrates in the Bay of Bengal. It is believed to be the largest and most concentrated discovery of gas hydrates anywhere in the world.³⁵ However, natural gas hydrates are currently uneconomic to produce with existing technology.

Indian companies are increasingly investing in U.S. gas projects in the hope of improving technical expertise that can eventually be used on the 17 potential shale oil and gas well sites

³⁰ U.S. Department of Energy, *U.S.-India Energy Cooperation*, Washington, DC, <https://energy.gov/ia/initiatives/us-india-energy-cooperation>.

³¹ U.S. Department of Energy, "DOE Announces Funding for U.S.-India Joint Clean Energy Research and Development Center," press release, May 16, 2011, <https://energy.gov/articles/doe-announces-funding-us-india-joint-clean-energy-research-and-development-center>.

³² Additional background on this program can be found at http://pacesetterfund.org/PACEsetter_Fund_Booklet_2nd_Funding_Round.pdf. In the booklet found at this link, the term "off-grid" is used. Off-grid is term meaning that a consumer of electricity is not getting their power supply from the main electrical grid, which includes large power plants and transmission lines. In India, many people live beyond the reach of its electrical grid and providing electricity to these people requires different methods to reach them.

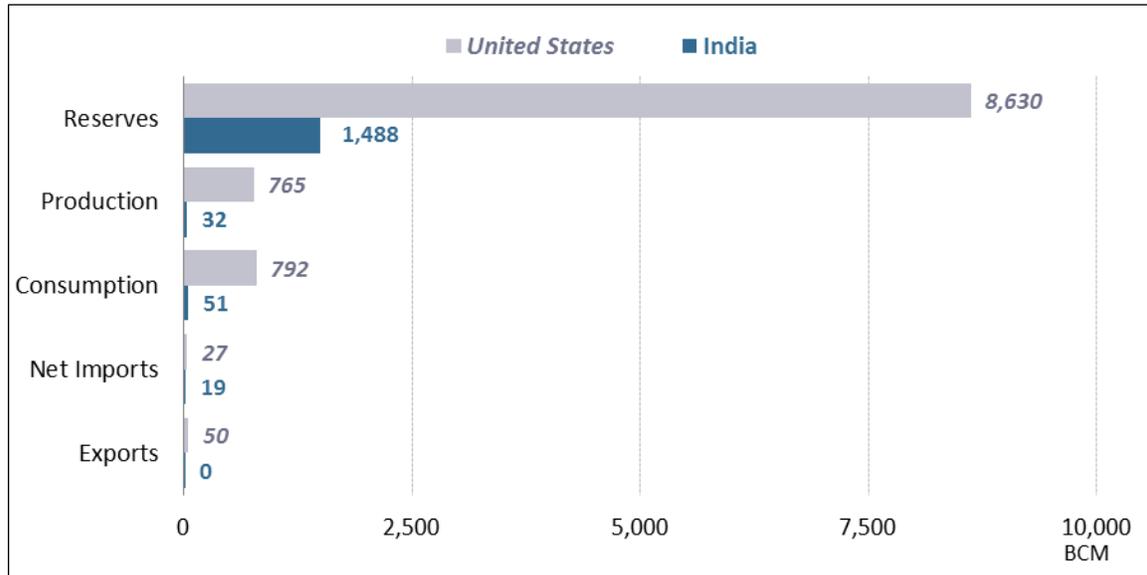
³³ The White House, "Joint Statement by President Obama and Prime Minister Singh of India," press release, November 8, 2010, <https://www.whitehouse.gov/the-press-office/2010/11/08/joint-statement-president-obama-and-prime-minister-singh-india>.

³⁴ Office of the Spokesperson, *U.S.-India Bilateral Cooperation on Energy and Climate Change*, U.S. Department of State, Washington, DC, June 13, 2012, <http://www.state.gov/r/pa/prs/ps/2012/06/192270.htm>.

³⁵ "India, US Hit upon Indian Ocean Natural Gas Discovery," *Phys.org*, July 26, 2016. For additional information on gas hydrates see CRS Report RS22990, *Gas Hydrates: Resource and Hazard*, by Peter Folger.

along the coasts of India.³⁶ For example, in 2011 GAIL bought 20% equity in a project located in the Texas Eagle Ford shale play,³⁷ while in 2012 OIL and IOC bought a 30% stake in a project located in Colorado's Niobrara shale oil and gas site.³⁸ U.S. natural gas reserves and production currently far exceed India's (see **Figure 2**).

Figure 2. India/U.S. Natural Gas Data, 2015



Source: Cedigaz Statistical Database (www.cedigaz.org), 2016.

Notes: Units = billion cubic meters (BCM). 1 cubic meter = 35.3 cubic feet. Reserves is an industry term that refers to an amount of natural gas that be produced with a high degree of certainty and with existing technology and market conditions.

Natural Gas Consumption: Not Meeting Its Targets

In 2015, Indian energy use was dominated by coal, which accounted for 58% of India's total energy consumption. This was followed by oil at 28%. In contrast, natural gas accounted for 7% of India's energy consumption. The GoI expected demand for natural gas to grow from 71 BCM in 2011-2012 to 170 BCM in 2016-2017.³⁹ Instead, India consumed just under 51 BCM in 2015. One likely explanation is due to the lack of growth in adequate infrastructure; the proliferation and integration of compressed natural gas into urban areas has not occurred as quickly as anticipated.

³⁶ Romany Webb and Janani Srinivasan, *India Invites Texas Energy Companies to Invest in its Shale Market*, Kay Bailey Hutchinson Center for Energy, Law and Business, Austin, TX, May 3, 2016, <https://kbhenergycenter.utexas.edu/2016/05/03/india-invites-texas-energy-companies-to-invest-in-its-shale-market/>.

³⁷ Carrizo Oil & Gas, Inc., "Carrizo Oil & Gas, Inc. Announces \$95 Million Joint Venture Agreement with GAIL (India) Limited," press release, September 28, 2011, <https://www.sec.gov/Archives/edgar/data/1040593/000119312511261634/d237532dex991.htm>.

³⁸ Sreeja VN, "Oil India, IOC Buy 30% Stake in Carrizo Oil & Gas Niobrara Shale Acreage," *International Business Times*, April 10, 2012.

³⁹ Government of India, Economic Sectors, Planning Commission, *Twelfth Five Year Plan 2012-17*, New Delhi, 2012, p. 176, http://planningcommission.gov.in/plans/planrel/12thplan/pdf/12fyp_vol2.pdf.

India's domestic consumption of natural gas is dominated by the fertilizer (34%), electric power (23%), refining (11%), local distribution (11%), and petrochemical (8%) industries (see **Figure 3**). In recent years the GoI has undertaken initiatives to make imported LNG more attractive, especially to the power and fertilizer industries. For electricity generation, the Ministry of Power, along with the Ministry of Petroleum and Natural Gas, directed natural gas pipeline companies to reduce their tariffs to support greater natural gas use in electric power generation.⁴⁰ In 2015, the GoI instituted a gas pooling policy to provide natural gas at a uniform price for all fertilizer plants.⁴¹

The GoI hopes that increasing the country's natural gas consumption will help meet the GoI's objective of reducing dependency on crude oil by 10% by 2022.⁴² In 2010, India already had the 5th largest natural gas vehicle fleet in the world,⁴³ with over 2.8 million natural gas vehicles.⁴⁴ The IEA forecasts that India will constitute the 3rd highest growth in natural gas vehicles through 2040, after the United States and China.⁴⁵ Indian companies are currently experimenting with ways to integrate natural gas into the transport industry. For example, Petronet and IOC are running a trial program of long-haul buses that run on LNG.⁴⁶

⁴⁰ Ministry of Power, *Scheme for Utilization of Gas-Based Power Generation Capacity*, Delhi, March 2015.

⁴¹ Press Information Bureau, "Pooling of Gas in Fertilizer (Urea) Sector," press release, March 31, 2015, <http://pib.nic.in/newsite/PrintRelease.aspx?relid=117888>.

⁴² IANS, "India to Invest \$20 Billion in Gas Fields in Next 5-7 Years: Dharmendra Pradhan," *The Economic Times*, November 30, 2016.

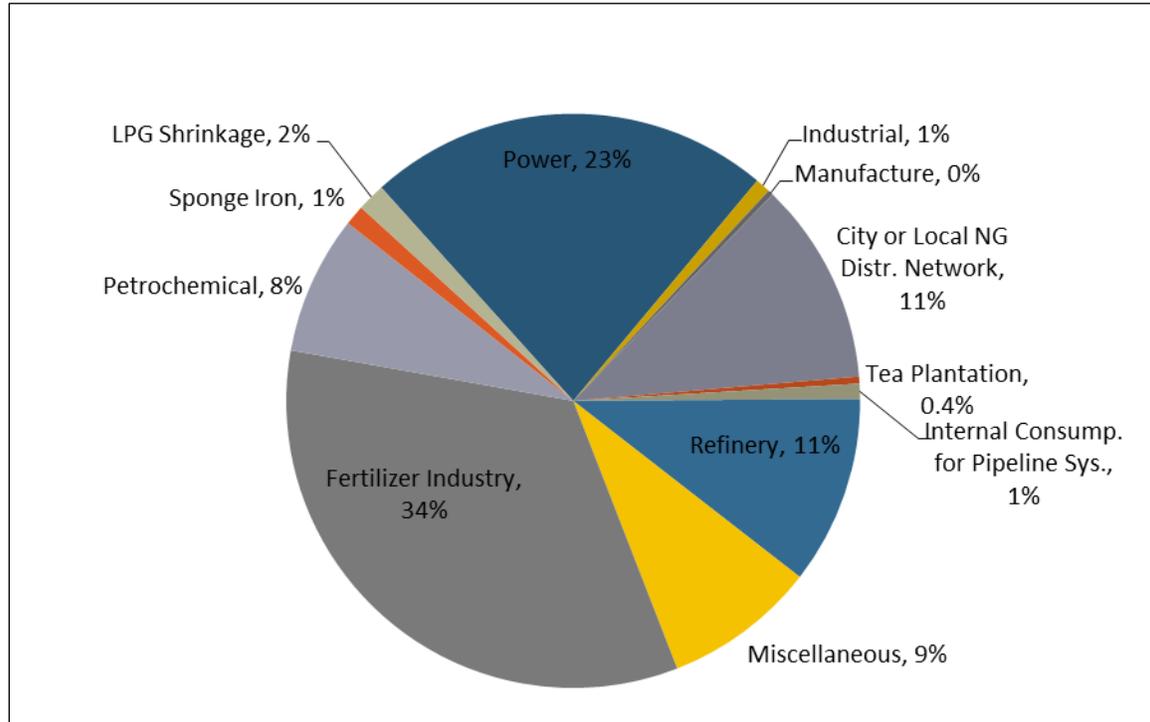
⁴³ Raymond E. Vickery, Jr., *India Energy: The Struggle for Power*, Wilson Center, Washington, DC, 2014, p. 44.

⁴⁴ "Promoting Natural Gas Vehicles in India," *Natural Gas World*, September 15, 2016. <http://www.naturalgasworld.com/ngw-magazine-promoting-natural-gas-vehicles-in-india-31635>.

⁴⁵ Saket Sundria, Debjit Chakraborty, and Rajesh Kumar Singh, "Most Polluted City Drives India to Champion Gas for Vehicles," *Bloomberg*, November 24, 2016. <https://www.bloomberg.com/news/articles/2016-11-24/most-polluted-city-drives-india-to-champion-gas-for-vehicles>.

⁴⁶ Saket Sundria, Debjit Chakraborty, and Rajesh Kumar Singh, "Most Polluted City Drives India to Champion Gas for Vehicles," *Bloomberg*, November 24, 2016. <https://www.bloomberg.com/news/articles/2016-11-24/most-polluted-city-drives-india-to-champion-gas-for-vehicles>.

Figure 3. India's Natural Gas Consumption by Industry
47,849 MCM, 2015-2016



Source: Indian Petroleum & Natural Gas Statistics 2015-16, Government of India.

Notes: Units = million cubic meters (MCM).

Natural gas consumption varies widely by region across India. For example, the states of Gujarat and Maharashtra in the west and Uttar Pradesh in the north consume more than 65% of the India's natural gas, while making up only 31% of the population.⁴⁷ The GoI is currently supporting initiatives to better balance the distribution and consumption of natural gas across the other regions of the country.

Expanding India's use of natural gas is constrained by lack of infrastructure, particularly pipelines to move natural gas throughout the country. India currently has 15,000 km (roughly 9,320 miles) of domestic natural gas pipelines. The Petroleum and Natural Gas Regulatory Board (PNGRB) has recently tendered bids for the planning and construction of another 15,000 km (see **Figure 4**).⁴⁸ Comparatively, the United States has approximately 484,826 km (301,257 miles) of natural gas pipelines as of 2015. India also lacks a broad network of distribution pipelines to move natural gas to consumers, especially residential users for heating and cooking. The GoI has recognized this shortcoming and has introduced plans to address it, but achieving their plans remains a goal.

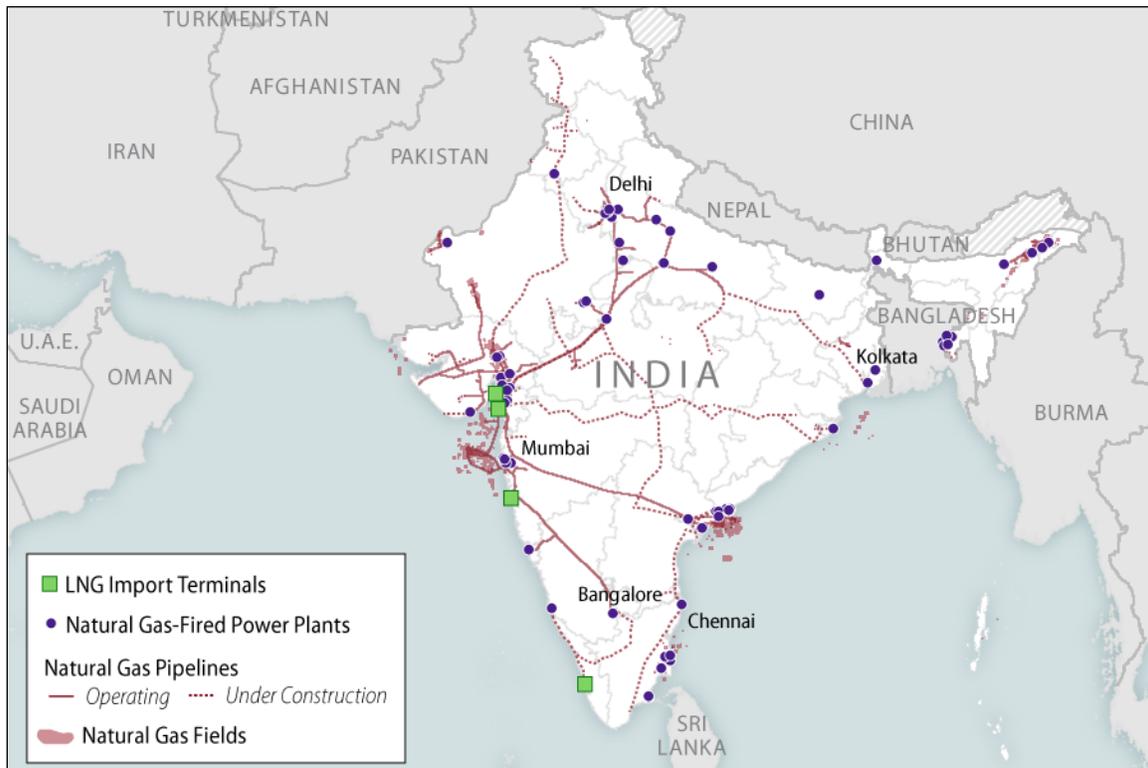
India is undertaking a concerted effort to bring low-carbon fuel sources to rural communities. Over the next three years the GoI is planning to connect 10 million households to the growing piped natural gas (PNG) network, a tripling of existing households. As of October 2016, 3.3

⁴⁷ Ministry of Petroleum and Natural Gas, *Natural Gas Scenario in India*, <http://petroleum.nic.in/docs/abtng.pdf>.

⁴⁸ Anupama Sen, *Gas Pricing Reform in India: Implications for the Indian Gas Landscape*, The Oxford Institute for Energy Studies, OIES Paper: NG 96, Oxford, April 2015, p. 49.

million households were connected to the PNG network.⁴⁹ Additionally, the GoI has launched the Ujjwala welfare program, which is to provide 50 million Indian families free liquefied petroleum gas (LPG)⁵⁰ connections over the next five years.⁵¹ Although LPG is not natural gas, this program fits in with the government's efforts to decrease in-home burning of wood and oil. In the first six months of the program one million families had already been provided with these free connections, which are intended to make rural households smoke-free.⁵²

Figure 4. Select Indian Natural Gas Fields and Infrastructure



Source: Congressional Research Service using data from IHS 2016, and Esri Data and Maps 2014.

Notes: LNG Import Terminals and Natural Gas-Fired Power Plants are existing and operating facilities. Hashed areas represent borders between other countries that are in dispute.

⁴⁹ PNGRB, *State-wise PNG & CNG Activities of CGD Entities as of 31.10.2016*, Delhi, October 31, 2016, <http://www.pngrb.gov.in/data-bank/PNG.CNG.Activities.8.12.16.pdf>.

⁵⁰ Liquefied petroleum gas (LPG) is primarily a combination of natural gas liquids (NGLs), such as propane and butane, and used as a fuel source. The mixture can be liquefied through pressurization, without cryogenic refrigeration.

⁵¹ Ministry of Petroleum and Natural Gas, *Pradhan Mantri UJJWALA Yojana and Other LPG Initiatives*, http://www.petroleum.nic.in/docs/PM_UJJAWALA_AND_OTHER.pdf.

⁵² Siddhartha P Saikia, "Free LPG connections Under Pradhan Mantri Ujjwala Yojana Cross 1 cr Mark," *The Financial Express*, November 8, 2016.

Environmental Commitments May Prompt Greater Gas Use

Although India has very low energy consumption per capita because of widespread poverty, it is among the top five biggest carbon emitters,⁵³ and faces major long- and short-term environmental challenges from climate change and local pollution. This stems from its use of coal in electric power generation, which accounts for 58% of India's total electricity production, as well as growing vehicular traffic, industry, and generally low energy efficiency.

During the Paris Climate negotiations in 2015 (COP-21) India was viewed as a recalcitrant nation, but one whose participation was deemed essential to meet emission reduction goals. India's Intended Nationally Determined Contribution (INDC), released after signing the Paris agreement, outlined India's intention to pursue a 33% to 35% reduction in carbon intensity as a percentage of GDP from 2005 levels by 2030. The Modi government also committed to produce 40% of power from non-fossil fuel sources by 2030⁵⁴ (non-fossil fuels currently comprise 7% of India's electricity generation). Additionally, the Ministry of Environment, Forest, and Climate Change mandated that new and existing power plants will face stricter limits for various emissions beginning in January 2017.⁵⁵ These restrictions favor increased natural gas-fired generation and renewables, and may promote greater use of both, if implemented and adhered to.

The GoI anticipates that meeting the goals set forth in the INDC will require \$2.5 trillion over fifteen years, or \$167 billion annually.⁵⁶ Paying for this massive commitment is a major hurdle for development, but also is inspiring creative schemes for financing green projects. For example, in 2015 India's YES BANK issued one of the first ever "Green Bonds," worth \$160 million.⁵⁷ This loan was backed up by the India Infrastructure Finance Company Ltd (IIFCL), as well as by the Asian Development Bank. Although a relatively small amount compared to the government's goals, it is one example of a finance scheme to generate capital for India to meet its sustainable development and emission reduction goals.

Government-Set Prices Limit Supply and Raise Demand

In October 2014, the GoI introduced a new natural gas pricing formula, which is linked to a grouping of various prices on the international market. This new arrangement has kept the price in a range acceptable to domestic gas-consuming sectors, but many gas-producing companies have argued that this scheme does not offer sufficient financial incentives to expand investments in exploration and production, particularly in the offshore.⁵⁸

⁵³ Johannes Friedrich, Mengpin Ge, and Thomas Damassa, *Infographic: What Do Your Country's Emissions Look Like?*, World Resources Institute, June 23, 2015, <http://www.wri.org/blog/2015/06/infographic-what-do-your-countrys-emissions-look>.

⁵⁴ Government of India, *India's Intended Nationally Determined Contribution*, Delhi, February 10, 2016, p. 29, <http://www4.unfccc.int/ndcregistry/PublishedDocuments/India%20First/INDIA%20INDC%20TO%20UNFCCC.pdf>.

⁵⁵ Types of emissions include particulate matter, sulphur dioxide, nitrogen oxides, and mercury.

⁵⁶ Government of India, *India's Intended Nationally Determined Contribution*, Delhi, February 10, 2016, p. 31, <http://www4.unfccc.int/ndcregistry/PublishedDocuments/India%20First/INDIA%20INDC%20TO%20UNFCCC.pdf>.

⁵⁷ "Yes Bank wins Green Bond Award in UK," *Economic Times*, February 23, 2016, <http://economictimes.indiatimes.com/industry/banking/finance/banking/yes-bank-wins-green-bond-award-in-uk/articleshow/51111727.cms>.

⁵⁸ Ali Al-Saffar, Marco Baroni, and Christian Besson, et al., *India Energy Outlook*, International Energy Agency, World Energy Outlook Special Report, Paris, 2015, p. 120, http://www.worldenergyoutlook.org/medi/weowebiste/2015/IndiaEnergyOutlook_WEO2015.pdf.

The price of natural gas in India is determined twice each year by the government through a weighted average of the Henry Hub (United States), National Balancing Point (U.K.), Russian gas, and Canadian Alberta gas prices.⁵⁹ The distribution of domestically produced gas is set by the government through its “Gas Utilisation Policy,” which rations domestically produced gas and distributes it to certain priority sectors before it is released for sale to the general public.⁶⁰ This is intended to benefit the so-called “Tier 1” industries (city gas for households and transport, fertilizer plants, grid-connected power plants).

Imported LNG is available at prices that are significantly higher than domestically produced natural gas. In recent years there have been proposals to combine LNG with domestically produced gas to make it more accessible for domestic use and to increase consumption of imported LNG in the power sector.⁶¹

In November 2016, the Modi government proposed creating an Indian natural gas hub, similar to the U.S. Henry Hub, which is a physical distribution hub, or the U.K.’s National Balancing Point, which is virtual pricing point.⁶² This development is intended to make the allocation of natural gas more efficient, make the market more dependable, and decrease political influence over trade.

Supply: Untapped Potential

India has many unexplored areas that may contain natural gas resources. India’s total reserves are estimated to represent only 0.8% of the global total,⁶³ but data are scarce for many of India’s sedimentary basins and require additional scientific exploration in order to better assess their potential for producing natural gas. Over the next five to seven years, India’s MoPNG plans to invest \$20 billion to further develop its offshore deepwater natural gas potential, which is viewed as having greater immediate returns.⁶⁴

India imports natural gas exclusively as LNG and will continue to do so in the near future. Despite some discussion of pipelines importing natural gas from Turkmenistan, Iran, and Russia, major political, security, and economic challenges must be overcome before becoming a viable option for India. India has emerged as one of the world’s largest markets for LNG because of the falling price of LNG due to an abundance of supply.

Onshore

Shale gas has the potential to increase natural gas role in India’s energy future. India has an estimated 96 trillion cubic feet (2,700 BCM) of shale gas resources and the resource has been identified in six main geographic areas (basins) spread throughout the country: Cambay, Assam-Arakan, Gondwana, Krishna-Godavari, Cauvery, and the Indo-Gangetic plain.⁶⁵ A shale policy

⁵⁹ Shine Jacob, “Not a Pipe Dream: Govt to Set Up National Gas Hub,” *Business Standard*, November 17, 2016.

⁶⁰ Anupama Sen, *Gas Pricing Reform in India: Implications for the Indian Gas Landscape*, The Oxford Institute for Energy Studies, OIES Paper: NG 96, Oxford, April 2015, p. 21.

⁶¹ *Ibid.*, p. 45.

⁶² Shine Jacob, “Not a Pipe Dream: Govt to Set Up National Gas Hub,” *Business Standard*, November 17, 2016.

⁶³ BP, *BP Statistical Review of World Energy 2016*, London, 2016, p. 20.

⁶⁴ Melissa Sustaita, “India in US \$20 Billion Deepwater Investment,” *Offshore Engineer*, December 1, 2016.

⁶⁵ U.S. Energy Information Administration, *Technically Recoverable Shale Oil and Shale Gas Resources*, India and Pakistan, Washington, DC, September 1, 2015, https://www.eia.gov/analysis/studies/worldshalegas/pdf/India_Pakistan_2013.pdf.

issued in October 2013 assigned the rights to exploit shale gas to the national oil companies, but was opened to private investment under the NELP X licensing program in 2014. Despite the potential, no commercial shale production exists in India today. Problems over land use, water availability, and acceptance by local communities are likely to be major factors in shale's potential contribution to Indian energy.⁶⁶ There is the potential for new gas discoveries onshore, but the potential for larger discoveries lies offshore.

Offshore

India's offshore territory remains largely unexplored. It is estimated that only 3,000 wells have been drilled in India's offshore basins. With an average density of one well per 146 km², Indian offshore production remains far behind that of the United States in the Gulf of Mexico, where there is an average density of one well per 14 km².

The deep-water Krishna-Godavari basin (KG) has historically been the center of Indian offshore natural gas extraction. In 2002, Reliance Industries discovered what was then considered India's largest natural gas reservoir (the KG-D6). Early optimism in the region has given way to a more pessimistic long-term outlook. Extraction from the deep-water discoveries has been technically challenging. This has led to high development costs, deterring potential investors. The KG-D6 project, which had an initial capacity of 2.8 billion cubic feet per day (29 BCM), has also suffered from major extraction performance issues and disputes with the GoI.⁶⁷ Recent pro-foreign investment signals from the Modi government have led to renewed optimism for KG-D6. For example, BP and Reliance Industries have withdrawn from arbitration proceedings against the GoI, and intend to produce four times as much natural gas by 2022.⁶⁸

HELP is intended to alleviate many of the previous bureaucratic barriers to investment in India's offshore resources.⁶⁹ Specifically, the new policy will allow companies to choose more narrow exploration blocks than required under NELP, improving chances for success, and will combine all hydrocarbon extraction under one single license. In contrast to its earlier policy, the GoI is now factoring in the degree of geological difficulty by providing incentives for exploiting offshore resources. For example, a graded system of royalty rates has been introduced, making profits increasingly more lucrative for energy companies if they choose an ultra-deep water block over a shallow water one.⁷⁰ Additionally, other incentives, such as an easier-to-administer revenue sharing model, are provided to companies that are awarded drilling blocks under this new system.

Imported LNG

India first began importing LNG in 2004, and by 2015 India had become the world's fifth largest importer of LNG behind Japan, South Korea, China, and Taiwan. In 2015, India imported a total

⁶⁶ Ali Al-Saffar, Marco Baroni, and Christian Besson, et al., *India Energy Outlook*, International Energy Agency, World Energy Outlook Special Report, Paris, 2015, p. 122, http://www.worldenergyoutlook.org/medi/weowebbsite/2015/IndiaEnergyOutlook_WEO2015.pdf.

⁶⁷ Ibid, p. 120.

⁶⁸ Saket Sundria and Debjit Chakraborty, "BP Aims to Increase Gas from India's KG-D6 Fourfold by 2022," *Bloomberg*, August 1, 2016.

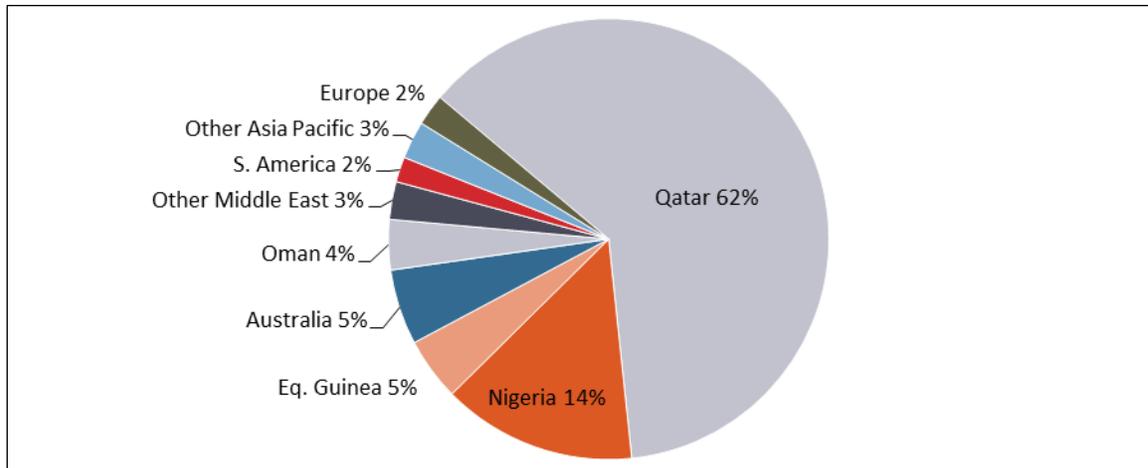
⁶⁹ HELP reforms fall in line with the GoI's "Ease of Doing Business" and "Minimum Government-Maximum Governance" initiatives, <http://www.makeinindia.com/about>.

⁷⁰ PMIndia, "Hydrocarbon Exploration and Licensing Policy (HELP)," press release, March 10, 2016, http://www.pmindia.gov.in/en/news_updates/hydrocarbon-exploration-and-licensing-policy-help/.

of 21.7 billion cubic meters (BCM) of LNG from 16 different countries: 62% from Qatar, 14% from Nigeria, 5% from Equatorial Guinea, and 5% from Australia (see **Figure 5**). In February 2016, India received its first LNG shipments from the United States. Given India's rising demand for LNG, and the growing U.S. LNG export capacity, it is likely additional U.S. natural gas will supply India in the future. For example, GAIL has signed an agreement with the Cove Point LNG facility in Maryland, which is under construction, for 50% of its capacity.⁷¹

Figure 5. India's LNG Suppliers, 2015

21.7 BCM total



Source: BP Statistical Review of World Energy, 2016.

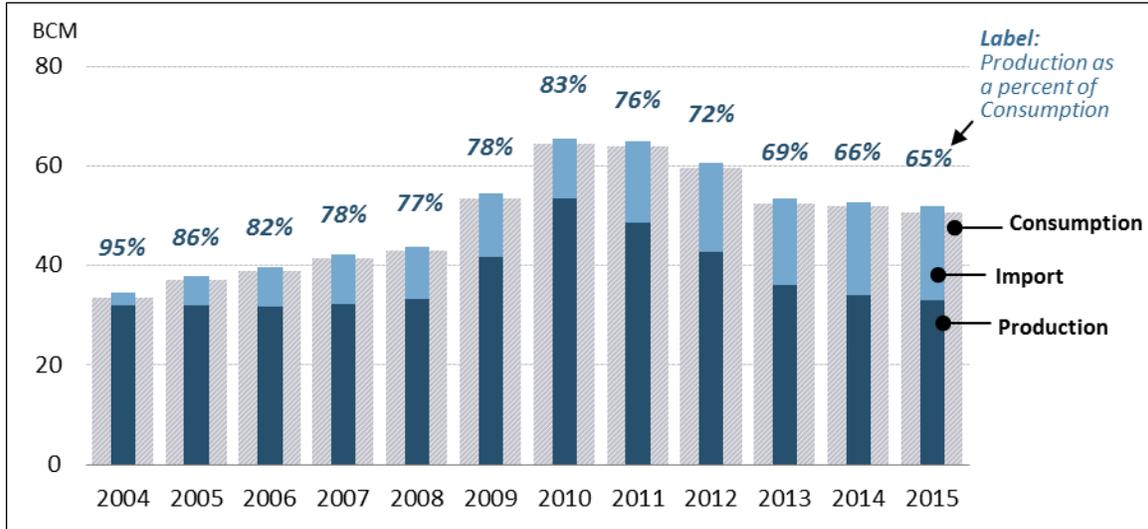
Notes: Units = billion cubic meters (BCM).

India's domestic production of natural gas peaked in 2010 and has declined annually ever since. India's consumption of natural gas has also declined since 2010, but not as quickly as production. LNG imports have been making up a greater percentage of consumption each year from 2010 to 2015 (see **Figure 6**). This is due in large part to an increased abundance of cheap global LNG supplies, an improved ability to absorb LNG imports, and regulated domestic. The increased global supply of natural gas has shifted the market to one that favors the buyers. This increased bargaining power by the consumer has allowed Indian companies like Petronet to renegotiate long-term natural gas contracts, especially pricing terms, and gain other favorable concessions from companies like Qatar's RasGas.⁷²

⁷¹ Saurabh Chaturvedi, "GAIL to Use Dominion's U.S. Gas Facility," *The Wall Street Journal*, April 1, 2013, p. online.

⁷² Leslie Palti-Guzman, *Asia's Energy Security Amid Global Market Change*, The National Bureau of Asian Research, Asia's LNG Prospects: Finally Entering a Golden Age, Seattle, WA, December 2016, p. 37, http://www.nbr.org/publications/specialreport/pdf/Free/02172017/SR63_AsiasEnergySecurity_December2016.pdf.

Figure 6. India's Natural Gas Production as a Percent of Consumption



Source: Cedigaz Statistical Database (www.cedigaz.org), 2016.

Notes: Units = billion cubic meters (BCM).

Due to India's proximity to major producers in the Middle East and Australia, it is likely to be a major LNG importer for years to come. Despite abundant global supplies of LNG, the resource remains too expensive to substitute for coal in electricity generation.

Table I. Existing and Proposed LNG Import Terminals

| Terminal | Region | Start Up | Operator | Status | Capacity (BCM) |
|------------------------|----------------|----------|--------------------------------------|--------------------|----------------|
| Dahej | Gujarat | 2004 | Petronet | Operating | 10.0 |
| Hazira | Gujarat | 2005 | Shell India | Operating | 5.0 |
| Kochi | Kerala | 2013 | Petronet | Operating | 5.0 |
| Ratnagiri | Maharashtra | 2013 | Ratnagiri Gas & Power | Operating | 2.5 |
| Mundra | Gujarat | 2017 | Gujarat State Petroleum Corp | Under Construction | 5.0 |
| Ennore | Tamil Nadu | 2019 | Indian Oil Corp. Ltd | Under Construction | 5.0 |
| Kakinda Deepwater Port | Andhra Pradesh | 2017 | Kakinda Deepwater Port | Proposed | 3.5 |
| Gangavaram | Andhra Pradesh | 2018 | Petronet & Gangavaram Port Authority | Proposed | 5.0 |
| Jafrabad LNG Port | Gujarat | 2017 | Swan Energy | Proposed | 5.0 |

Source: World LNG Map, 2016 edition, produced by Petroleum Economist.

If India is to increase reliance on natural gas, it would also require improving existing infrastructure and building new infrastructure. As of 2016, India had four operational LNG terminals, giving it a total import capacity of 22.5 BCM (see **Table 1**). Should all of these LNG terminals currently under construction and proposed be built, India's LNG import capacity could reach 41 BCM by 2019. This development would drastically improve access to natural gas along India's eastern seaboard, and possibly make it a more competitive alternative to coal.

Pipeline Imports: A Work in Progress

Increasing India's natural gas supply via international pipelines has centered primarily on two potential projects: the Turkmenistan-Afghanistan-Pakistan-India (TAPI) pipeline and the Iran-Pakistan-India (IPI) pipeline, both of which have been in development for many years. A third project has been proposed more recently to bring Russian natural gas to India, the Russia-India pipeline. TAPI has long been supported by the United States due to its potential to produce an economic windfall for Afghanistan. Though a ground-breaking ceremony for the project took place in Turkmenistan in 2015, there are still significant political and commercial obstacles to overcome, such as transiting Pakistan, if it is to be completed by its target date of 2019.⁷³

With the loosening of sanctions on Iran's oil and gas industry, the prospects for the IPI pipeline were expected to improve. This renewed optimism was seemingly put to rest in 2016 when Iran's ambassador to India declared the project to be dead.⁷⁴ The ambassador cited the lack of major investments in India's LNG infrastructure and the perceived inevitability that the United States would oppose its construction as the two major reasons for his pessimism. These two reasons are in addition to India's concerns of possibly relying on Pakistan as a natural gas transit country for Iranian natural gas.

In October 2016, India and Russia agreed to build a 4,500 km to 6,000 km-long pipeline from Siberia estimated to cost \$25 billion. However, the parties involved estimate the cost to transport Russia's natural gas to be at least double that of TAPI or IPI. In light of this, the two countries are now exploring an alternative gas swapping scheme involving China and Burma.⁷⁵

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⁷³ Barnett Rubin, "The TAPI Pipeline and Paths to Peace in Afghanistan," *The New Yorker*, December 30, 2015.

⁷⁴ Iftikhar Gilani, "India-Pakistan-Iran Pipeline Highly Unlikely Now, Confirms Iranian Envoy," *Daily News & Analysis*, April 24, 2016.

⁷⁵ Press Trust of India, "India in Talks with Russia to Swap Natural Gas with China," *India.com*, December 7, 2016.