



2016 Top Markets Report **Civil Nuclear** Country Case Study

India

Market Type: Existing and Expanding

India has a large nuclear power program with substantial political support and aims to supply 25 percent of its energy from nuclear power by 2050. This expansion presents significant opportunities for U.S. industry, especially as the Indian government works to engage foreign firms in its plans. Nevertheless, ownership limitations and nuclear liability concerns remain serious barriers for U.S. civil nuclear exports.

New Builds

2

Existing Reactors

1

Decommissioning

5

Overall
Rank

3

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India has a rapidly growing nuclear power program, with 21 operating nuclear reactors, six under construction and 22 additional reactors planned. The Nuclear Power Corporation of India (NPCIL), the state-owned operator of India's reactor fleet, supplies 5.3 GWe of nuclear capacity, 3.5 percent of India's current electricity generation. India aims to increase nuclear generation to 25 percent of its energy mix by 2050. India's current nuclear power market is estimated at \$150 billion and will grow further if its expansion plans are realized.

The Government of India (GOI) is supportive of nuclear power due to the country's growing electricity demand and shortage of fossil fuels. Because India is not a signatory to the Nuclear Non-Proliferation Treaty (NPT), it was excluded from nuclear trade for 34 years, which limited its nuclear energy development to mostly indigenous designs. Since 2008, when U.S.-led efforts lifted Nuclear Supplier Group (NSG) trade restrictions, India has worked with other countries (primarily Russia,

France and the U.S.) to develop its program. NPCIL is responsible for design, construction, commissioning and operation of plants but views international cooperation as an opportunity to expand its domestic program and eventually become an exporter of reactor technology.

To expand its program, India plans to build nuclear parks, with supply from foreign companies. Each park is to have 8 to 10 GWe of generation capacity – an impressive increase from the current capacity of any single site currently operating in India. U.S., French and Russian companies have been in talks and, in some cases, have reached deals to build nuclear reactors. India's limited uranium reserves have led it to pursue a long-planned three-stage program to support a thorium fuel cycle.

Public opinion regarding nuclear power is generally positive. Following Fukushima, public concern triggered protests against new reactors. Within a year, however, poll numbers bounced back, showing a growing approval for nuclear energy. In 2012, British polling firm Ipsos Mori found that 75 percent of Indians supported nuclear energy. In response to Fukushima, NPCIL

implemented safety upgrades at all of India's operating NPPs.

Before 2008, when India's nuclear market was cut off from nuclear trade, India's nuclear power plants (NPPs) operated under capacity due to a shortage of uranium fuel. The 2008 U.S.-India nuclear deal has since removed sanctions against India, enabling India to import uranium and construct large foreign-built nuclear reactors. Currently, 40 percent of India's nuclear capacity operates under the IAEA safeguards and uses imported fuel.

Planned Nuclear Energy Projects

India is currently planning to build 22 reactors at 15 sites. The next project to start construction will be the Kudankulam 3 and 4 plants in Tamil Nadu, which are scheduled to begin construction in 2016 and 2017 with operation to begin in 2022 to 2023. In total, India is planning to build 21,300 MWe of nuclear power.

As part of the 2008 U.S.-India nuclear deal, two prospective sites in Gujarat and Andhra Pradesh will involve U.S. reactor vendors Westinghouse (WEC) and GE-Hitachi (GEH). In March 2009, GEH signed an agreement with NPCIL and Bharat Heavy Electricals to build its advanced boiling water reactor (ABWR) at Kovvada in Andhra Pradesh. Also in 2009, WEC signed a memorandum of understanding (MOU) to build its AP1000 reactor at Mithi Virdi in Gujarat, in cooperation with NPCIL and India's Larsen & Toubro. In December 2015, WEC and NPCIL announced expanded plans to build six reactors in India by 2030. WEC negotiations with NPCIL are more advanced than those of GEH, primarily due to the fact that GEH's ABWR is not yet licensed by the U.S. NRC.

In March 2016, NPCIL and France's EDF signed an MOU to construct six European Pressurized Reactors (EPR) of 1650 MWe each at Jaitapur in Maharashtra. Russia's Rosatom is currently constructing its VVER-1000 reactor at Kudankulam 2 and has announced plans to build six NPPs (VVER-1200 reactors) in India over the next 20 years.

All plants are owned and operated by NPCIL, except for a planned fast breeder reactor handled by the specialist fast breeder division Bhavini.

Commercial Opportunities

Services (front-and back-end): Moderate opportunities for feasibility studies and infrastructure development at India's planned NPPs.

Legal and Consulting Services: Moderate opportunities to advise NPCIL and DAE on new plant projects.

Licensing Support: Opportunities to support the Atomic Energy Regulatory Board (AERB), India's nuclear safety regulator.

Design, Construction, and Operation: Opportunities exist for new construction of 22 reactors, along with many others proposed. Foreign companies are only allowed minority stakes, however, as the 1962 Atomic Energy Act prohibits private control of nuclear power generation.

Components: Opportunities may exist for future plants.

Challenges and Barriers to Exports

While GOI support for nuclear energy is strong and the government wants foreign company involvement in the expansion of its nuclear program, there are several obstacles for U.S. civil nuclear exports. First, India's plan to build nuclear parks is moving forward at a slower pace than anticipated. Additionally, India has signed a civil nuclear cooperation agreement with United States but not with Japan, which may limit some technology use involving Japanese firms (India has agreed to a civil nuclear agreement with Japan in principle). Lastly, India's 1962 Atomic Energy Act prohibits private control of nuclear power generation, which may limit U.S. company involvement in India's nuclear projects.

Liability is another concern. India ratified the Convention on Supplementary Compensation for Nuclear Damage (CSC) in February 2016, and the U.S. government and the GOI have agreed that India's 2010 domestic Civil Liability for Nuclear Damage Act (CLND) is compatible with the CSC. Some U.S. suppliers, however, still have concerns about the interpretation of the CLND and its channeling of liability exclusively to the operator. To alleviate supplier concerns, India has created an insurance pool for nuclear operators in India and for foreign suppliers with a liability cap of 15 billion Indian Rupees (\$226 million).

Nuclear Infrastructure

Research reactors: India has four research reactors. The Bhabha Atomic Research Center (BARC) operates two, while the Indira Gandhi Center for Atomic Research operates two others.

Fuel: Expertise exists in all areas of the nuclear fuel cycle, including exploration, mining, heavy water production, fabrication and reprocessing. India's long-term goal is to develop an advanced heavy-water thorium cycle. India has some domestic uranium mining handled by the Uranium Corporation of India, Ltd (UCIL) but relies on 40 percent imported uranium to fuel its growing reactor fleet.

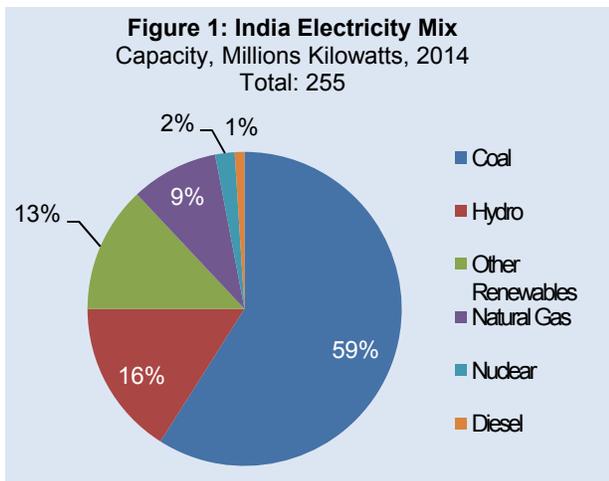
Waste Management: Waste is treated and stored at each NPP site. Waste immobilization plants are in operation. BARC is conducting research on final disposal of waste in a geological repository.

overcoming remaining obstacles to U.S.-India civil nuclear cooperation.

U.S.-India Strategic & Commercial Dialogue (S&CD): In September 2015, the previous U.S.-India Strategic Dialogue was elevated to the S&CD with the primary focus of advancing shared objectives in regional security, economic cooperation, defense, trade and climate challenges.

U.S.-India High Technology Cooperation Group (HTCG): Established in 2002 to promote bilateral high technology commerce (specifically dual-use items) in partnership with the private sector. The HTCG is led by DOC's Bureau of Industry & Security (BIS).

U.S.-India Energy Dialogue: Launched in 2005 and led by the U.S. Department of Energy (DOE), this dialogue includes a Civil Nuclear Working Group that guides bilateral civil nuclear R&D efforts.



Global Center for Nuclear Energy Partnership: Established in 2010 by DOE's National Nuclear Security Administration (NNSA) and the GOI, the center focuses on bilateral nuclear security cooperation and other capabilities to secure vulnerable nuclear materials.

USG Cooperation

123 Agreement: The U.S.-India 123 Agreement entered into force in 2008. This made India the first country with known nuclear weapons and that is not a member of the NPT to engage in international nuclear commerce.

U.S.-India Civil Nuclear Contact Group: In January 2015, President Obama and Prime Minister Modi reached a bilateral "mutual understanding" that seeks to set a framework for the U.S. nuclear industry to enter commercial talks on building reactors in India by resolving concerns regarding liability and inspections. The U.S.-India Civil Nuclear Contact Group, made up of officials from the USG and the GOI, was charged with

Figure 2: Additional Agreements	
Non-Proliferation Treaty	
IAEA Comprehensive Safeguards Agreement & Additional Protocol	✓
Joint Convention on Safety of Spent Fuel Management	
Convention on Nuclear Safety	✓
Convention on Early Notification of a Nuclear Accident	✓
Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency	✓
Paris Convention on Third Party Liability in the Field of Nuclear Energy	
Vienna Convention on Civil Liability for Nuclear Damage	
Joint Protocol Relating to the Application of the Vienna Convention and Paris Convention	
Convention on Supplementary Compensation for Nuclear Damage	✓
Organization Membership	
IAEA	✓
Nuclear Suppliers Group	
OECD/NEA	
IFNEC	✓
GenIV International Forum (GIF)	

Resources

For more information on commercial opportunities in India, contact: John M. McCaslin (Senior Commercial Officer, John.McCaslin@trade.gov), Parthasarathy Srinivas (Commercial Officer, P.Srinivas@trade.gov) I&A Civil Nuclear Team: Jonathan Chesebro (jonathan.chesebro@trade.gov).

For more information on nuclear energy in India, see: India Department of Atomic Energy: <http://dae.nic.in/>

Atomic Energy Regulatory Board: <http://www.aerb.gov.in/>

Nuclear Power Corporation of India Ltd (NPCIL): <http://www.npcil.nic.in/>

Sources

CIA Factbook, United Nations, World Nuclear Association, Asian Development Bank, and our contacts at the U.S. Embassy in New Delhi and U.S. Consulates in India.