China

Market Type: Existing and Expanding

China is aggressively expanding its nuclear fleet to reduce air pollution from coal-fired power plants and keep pace with economic growth, but electricity demand growth slowdowns have partially delayed new reactor construction. While technology indigenization, local content requirements and self-sufficiency limit foreign participation, nuclear sector growth in the next decade will ensure commercial opportunities for U.S. civil nuclear exporters.

U.S. Ambassador to China: Max Baucus
U.S. Commerce Attaché to China: Sarah Kemp

China has 33 operational nuclear reactors with a total installed capacity of 28.31 GWe. Of these, two are Russian VVER models, two are Candu PHWRs and the rest are Chinese designed PWRs that are chiefly derived from French models. 22 reactors are under construction with a total installed capacity of 26.72 GWe. China ranks first in the world for number of units under construction. In 2015, eight new reactors were connected to the grid, and nuclear power accounted for about 3.01 percent of the country’s generating capacity.

In October 2012, China’s former Premier, Wen Jiabao, outlined a post-Fukushima approach to nuclear power development, which consists of China employing a steady pace in its effort to build new nuclear power plants (NPPs) while complying with new generation safety standards. In recent years, China has tried to reduce its nuclear capacity target to 58 GWe by 2020 from the previous goal of 80 GWe, but this still represents a remarkable tripling of existing capacity. Also in October 2012, the State Council approved the “12th Five-Year Plan for Nuclear Safety and Radioactive Pollution Prevention and Vision for 2020,” in which China delineated its plans to spend RMB 80 billion ($13 billion) to improve nuclear safety at 41 operating and under construction reactors over the next three years. Such actions in response to the Fukushima accident highlight a perceived need to improve the reputation of Chinese firms on issues regarding safety and quality as well as the increasing strain on the Chinese nuclear regulator to enlarge its ranks of experienced personnel to meet rapid expansion.

During the 13th Five-Year Plan (2016-2020), China will focus on constructing coastal NPPs; building indigenous nuclear demonstration projects; completing Sanmen and Haiyang AP1000 projects; building Fuying, Fangchenggang Hualong One demonstration projects; starting construction of Rongcheng CAP1400 demonstration project; accelerating construction plans for Tianwan units 5 and 6; active preparation of inland NPPs; accelerating and facilitating large commercial reprocessing plant construction; and strengthening its nuclear fuel security system.
China aims to become a reactor design exporter and compete alongside established companies for reactor tenders worldwide. Its policy of indigenizing foreign technology, though helping to expand China’s reactor design and engineering capabilities, has thus far limited China’s ability to export its designs, as its technology transfer agreements—with Westinghouse for the AP1000, for example—forbid China from exporting indigenized designs below a specified power threshold. China has recently developed two designs for export: the ACC1000 (also known as the Hualong One, a recent merger of the AP1000 and ACPR1000 designs) and the CAP1400, which is based on the Westinghouse AP1000 model but scaled to a power capacity allowing China export rights. China National Nuclear Corporation (CNNC) and China General Nuclear (CGN) signed a joint venture to promote the Hualong One and export Generation III reactors globally. Construction on the first reactors for each design has been delayed twice but is scheduled to begin for Fuqing-5 and Fuqing-6 in May 2016 and December 2016.

In January 2015, China announced an incentive and financial program for nuclear exports. A few months later, an agreement was signed with Argentina to build two reactors mostly financed by China. The first reactor is a Candu type reactor to be delivered in 2016 while the second is a Hualong One reactor.

China is supporting civil nuclear projects in the UK, including CGN’s 33.5 percent ownership in the Hinkley Point C site and 20 percent ownership in the EDF-controlled Sizewell site. EDF’s European Power Reactor (EPR) is to be build at both sites. In exchange for Chinese funding, EDF will take a 33.5 percent stake in the Bradwell site, where the Chinese designed Hualong One reactor will be built. This will be the first Chinese-designed reactor to be built in a Western country.

China has a vast R&D portfolio that includes all aspects of the fuel cycle. It is pursuing fast reactor, HTGR, and SMR demonstration projects as well as expanding its capabilities for uranium mining, enrichment, fuel fabrication and reprocessing. In nearly all of these areas, China is developing its own technology as well as partnering with foreign governments and industry to import technology.

**Planned Nuclear Energy Projects**

China is targeting 58 GWe of installed nuclear capacity by 2020, and further increases are planned thereafter. Domestic designs will make up the majority of new reactors, but China will continue to engage with U.S., French, Russian and Canadian industries for others. The Chinese government and state-owned enterprises work directly with international vendors for planning new reactors rather than conducting an open bidding process.

**Commercial Opportunities**

*Services (front-and back-end): Opportunities for probabilistic risk assessment and regulatory advisory services*

*License Support: Opportunities to support China’s National Nuclear Safety Administration (NNSA)*

*Design, Construction, and Operation: Significant opportunities for new nuclear plant construction. Components: The interim portion of the NPP supply chain represents the largest current opportunity for U.S. exporters. Under China’s mammoth nuclear energy expansion, China is building plants of two basic types. The first are Generation II reactors based on technology already mastered by Chinese domestic producers. The second are Generation III reactors for which China is still largely dependent on foreign suppliers. Currently, China plans to manufacture 50 to 60 percent of the units domestically, based on the older Generation II technology, leaving 40 to 50 percent of the market for Generation III nuclear equipment imports, an estimated $15 billion in market value. In the downstream market, similar to the interim market, the quality of products produced by most Chinese domestic manufacturers does not meet the demand of Chinese buyers. The best prospects for U.S. exporters in the downstream market are nuclear pumps and valves, breakers, large forging parts and other accessories.*

*Fuel Management: China is not fully self-sufficient in the upstream market of raw materials used in NPPs. Chinese mines produce 70 percent of the uranium used in Chinese reactors. Chinese imports of U.S. graphite moderator rods recently increased. China is now the third largest buyer, after Japan and Canada, of U.S. graphite.*

**Challenges and Barriers to Exports**

Local content requirements are a key barrier for U.S. civil nuclear exports. China has an explicit policy of technology transfer, and it has become increasingly self-
It has gained experience in constructing new reactors and other fuel cycle facilities, to the effect that new reactor builds in the near future may contain as much as 85 percent local content. Strong foreign competition is also a challenge and will limit market access for U.S. industry. Nonetheless, the size of China’s market is so large and the pace with which it is building new reactors and facilities is so swift that China will remain a strong and dynamic market for U.S. exports for years to come for all areas of the civil nuclear sector.

Government support is strong mainly due to intense pressure to find new sources of clean electricity, and it appears unlikely at this time that government policy will significantly change. Public opinion regarding nuclear energy in China is complex. On the one hand, a few cases of public opposition to new nuclear plants have caused delays or halts to planned projects, most noticeably with the postponement of construction at new inland sites. On the other hand, strong public sentiment toward achieving clean air goals may make the public more supportive of nuclear energy. It is unclear how much public opinion influences China’s central government-driven policy decisions, though the government has recently shown a marked increase in public outreach regarding nuclear policy.

Liability is a concern. China has not committed to signing the CSC. With Japan’s ratification and the CSC entry into force, however, China may have a bigger incentive to adopt it, and government officials have indicated an interest in reviewing current policies to determine their compatibility with the CSC.

China’s response following Fukushima has helped instill faith in the country’s regulatory and safety regimes, and the slow pace (albeit the fastest in the world) of new construction will help ensure it can maintain financial capability to handle its plans.

China remained on the USTR 301 Priority Watch List in 2015 due to a lack of effective protection of IPR, including patents, copyrights, trademarks and trade secrets. Although China has been taking steps to overhaul its IPR laws, this continues to be a challenge to doing business in China and puts a strain on U.S. industry relations with Chinese entities.

Nuclear Infrastructure

Research Reactor: China has 19 research reactors. The China Institute of Atomic Energy (CIAE) is the leading organization for basic nuclear science research and runs the China Experimental Fast Reactor.

Fuel: CNNC is responsible for domestic production and overseas development of uranium. More than 2 million tU of potential resources have been identified in China, but current production (1,800 tU per year) cannot meet China’s current and future needs. Even with increased production, China will need foreign imports to meet demand. China imports uranium from a variety of countries, mainly Kazakhstan, Canada and Australia, and has acquired equity in uranium mines in Kazakhstan, Namibia, Niger and Uzbekistan.

Waste Management: A centralized fuel storage facility has been built at Lanzhou Nuclear Fuel Complex. Regional storage centers are under development. Construction on a geological repository is planned for 2040 to open by 2050. Site selection is currently underway.

Figure 1: China Electricity Mix
Capacity, Millions Kilowatts, 2015
Total: 1082.493
3% Nuclear
19% Hydro
71% Renewables
7% Fossil Fuels

U.S. Government Collaboration

123 Agreement: The successor 123 Agreement with the United States entered into force in November 2015.

May 2013 Trade Mission: In May 2013, then DOC Undersecretary for International Trade led a delegation including senior U.S. government officials from DOC, DOE, Ex-Im Bank and U.S. industry to work with the Chinese government on U.S.-China nuclear power cooperation.

Peaceful Uses of Nuclear Technology (PUNT) Agreement: United States and China meet annually on nonproliferation and nuclear energy cooperation topics,
including joint work on probabilistic risk assessment training for Chinese operators.

**International Engagement**

China has extensive international engagement. It signed an agreement with Areva and EDF in 2013 on reactor development and is taking partial ownership of the planned reactors at Hinkley Point in the UK. It recently signed a deal with Russia for more VVERs at Tianwan and for fast breeder reactors. It has also expanded ownership in uranium mines in Africa. In 2015, state owned China General Nuclear Power Group signed a Memorandum of Understanding with Kenya as well as a contract with Argentina to deliver two reactors.

**Figure 2: Additional Agreements**

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<th>Category</th>
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<tr>
<td>Non-Proliferation Treaty</td>
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<tr>
<td>IAEA Comprehensive Safeguards Agreement &amp; Additional Protocol</td>
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<tr>
<td>Joint Convention on Safety of Spent Fuel Management</td>
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<tr>
<td>Convention on Nuclear Safety</td>
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<td>Convention on Early Notification of a Nuclear Accident</td>
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<tr>
<td>Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency</td>
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<tr>
<td>Paris Convention on Third Party Liability in the Field of Nuclear Energy</td>
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<tr>
<td>Vienna Convention on Civil Liability for Nuclear Damage</td>
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<tr>
<td>Joint Protocol Relating to the Application of the Vienna Convention and Paris Convention</td>
<td>✓</td>
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<td>Convention on Supplementary Compensation for Nuclear Damage</td>
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**Organization Membership**

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<td>Nuclear Suppliers Group</td>
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<td>IFNEC</td>
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<td>GenIV International Forum (GIF)</td>
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**Resources**

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**Sources**

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