



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

South Korea

Market Type: Existing and Expanding

The Republic of Korea (ROK) has indigenized its nuclear power industry to the extent that new builds no longer rely heavily on U.S. content. The ROK has emerged as a leading competitor after it won a bid for the Barakah plant in the United Arab Emirates. Despite domestic self-sufficiency, a long history of cooperation with U.S. industry ensures future export opportunities.

New Builds

25

Existing Reactors

7

Decommissioning

12

Overall Rank

13

The Republic of Korea (ROK) currently has 25 operational nuclear reactors with a net capacity of 23.01 GWe. Three reactors consisting of an additional 4.20 GWe are under construction. Korea's reactors are located at four sites; all new builds are expected to be at these sites.

From Korea's first reactor, which achieved commercial operation in 1978 to the late 1990s, Korea's reactor fleet consisted of a variety of foreign designs: six Westinghouse PWRs, four Candu PHWRs, two Framatome (now Areva) PWRs and two Combustion Energy (C-E, now owned by Westinghouse) PWRs. In 1987, Korea began a 10-year technology transfer plan with C-E. The resulting design, the OPR-1000, was largely based on C-E's System 80 model and became the sole design for Korea's subsequent new builds. Ten OPR-1000s have become operational since 1998, with the latest entering operation in July 2015.

The Generation-III APR-1400, based on the C-E System 80+ model, is the successor to the OPR-1000. Three APR-1400s are under construction in Korea with the first to be operational in 2017. Korea is marketing the

APR-1400 for export, citing its superior safety features, low generation cost per kilowatt-hour and short construction time, which, according to the Korea Atomic Power Company (KEPCO), has been reduced to 41 months. Four APR-1400s are currently being built in UAE at Barakah, with the reactors entering service between 2017 and 2020.

A series of corruption scandals in 2012 and 2013 regarding falsified quality assurance certificates for reactor components caused President Park Geun-hye to pledge a review of all reactors and a probe into the state-run Korea Hydro & Nuclear Power Co. (KHNP). A total of five reactors were taken offline temporarily, and three that were under construction were delayed while parts that failed testing were replaced, in part by U.S. suppliers. In December 2013, the Korean government announced a reduction of its new nuclear construction goals to 29 percent of its energy mix by 2035, down from the previous goal of 41 percent by 2030. This still represents a marked increase in its current nuclear power generation capacity.

The Korea Atomic Energy Research Institute (KAERI) is developing a 100 MWe SMR, called SMART (System-integrated Modular Advanced Reactor), that it intends to market for export. It has entered discussions with Saudi Arabia to build a SMART reactor in cooperation with KA-CARE.

Planned Nuclear Energy Projects

Construction on six new reactors is planned over the next five years: four at Shin Kori and two at Shin Hanul. All will be the APR1400 design. In 2015, KEPCO announced that a plant was planned for construction at Cheonji, with two APR+ 1500 MWe reactors projected to come online around 2027.

Commercial Opportunities

Design, Construction, and Operation: Mostly concentrated with local companies.

Components: Mostly concentrated with local companies.

Challenges and Barriers to Exports

The ROK's policy of technology transfer and indigenization has greatly reduced market access for U.S. industry, particularly for new builds. Korea was once a premier destination for U.S. civil nuclear exports, as U.S. reactor vendors joined those of France and Canada to supply Korea with 14 of its first 15 reactors. Korea now exclusively relies on indigenous designs for its new reactor builds, and the amount of local content on these reactors has become high. Recently, Korea's growing capabilities and export ambitions have turned it into a direct competitor with U.S. industry for exports to third countries, most noticeably with UAE, where a Korean consortium beat out GE-Hitachi and Areva for the Barakah tender.

In this respect, Korea's civil nuclear program has served as a model for China, whose program is enacting a similar strategy of technology transfer and indigenization. One of the chief differences, however, is that China's plans for new nuclear power are so vast that China is still reaching out to foreign vendors to supply some of its new build capacity, albeit with high local content quantities. Korea is no longer doing this.

Despite Korea's achievements in self-sufficiency, U.S. industry has strong ties to the Korean civil nuclear

market, and there are still ample opportunities for exports of goods and services. Westinghouse, for example, is supplying up to \$2 billion in components and technical support for the Barakah nuclear power plant in UAE. Westinghouse is also involved in a joint venture with KNFC to make control element assemblies for combustion engineering-designed power reactors in the ROK. More recently, several U.S. companies won contracts with KHNP for technical advisory services for re-verification of equipment and material procurement processes following the false certification scandal.

Government support for the country's nuclear program remains high. Official targets for future nuclear generating capacity, though reduced from a year earlier, still represent strong growth of nuclear power in Korea for years to come, and plans for exporting do not appear to be diminished. Korea scores highly on all financial indicators. Liability, however, continues to be an issue. Despite efforts by U.S. government and industry, Korea has not yet agreed to adopt the CSC.

Nuclear Infrastructure

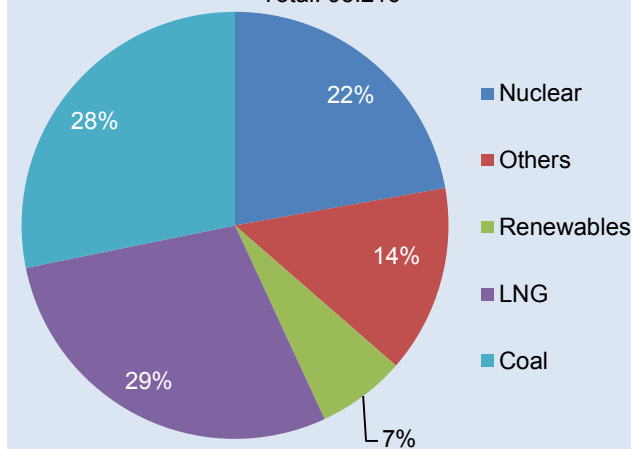
Research Reactor: KAERI has a 30 MWt research reactor that started operation in 1995. It is the basis for the research reactor it is exporting to Jordan.

Fuel: Fuel for Korea's reactors comes from overseas, including Kazakhstan and Canada. Korea has a small quantity of uranium deposits, and mining at the Daejeon site is planned for the near future.

Waste Management: Low and intermediate-level wastes are stored at each reactor site. A central disposal repository is being built at Gyeongju. The Korea Radioactive Waste Management Co. Ltd (KRWM) was set up early in 2009 as an umbrella organization to resolve South Korea's waste management issues and waste disposition and, in particular, to create a national consensus on high-level wastes.

In 2020 nuclear capacity of 27.3 GWe is expected to supply 226 billion kWh - 43.4 percent of electricity - before rising to 48 percent in 2022, though some recent projections suggest 50 percent by 2020, with the use of gas strongly reduced. By 2030, the government expects nuclear to supply 59 percent of the power (333 TWh) from 41 percent of the installed capacity.

Figure 2: South Korea Electricity Mix
Capacity, Millions Kilowatts, 2014
Total: 93.216



U.S. Government Collaboration

123 Agreement: The United States and the ROK signed a new 123 Agreement on June 16, 2015.

U.S.-ROK High-Level Bilateral Commission (HLBC): established in March 2016 under the U.S.-ROK 123 Agreement as a forum to handle follow-on cooperation on assured fuel supply, spent fuel management and joint export promotion.

U.S.-ROK Joint Standing Committee on Nuclear Energy Cooperation (JSCNEC): U.S. State Department led cooperative initiative in the areas of nuclear energy, nonproliferation, nuclear safety, safeguards, export controls and nuclear security, and emergency preparedness.

International Engagement

In December 2009, the ROK won a bid to build four nuclear reactors in the United Arab Emirates worth \$20 billion. It is actively seeking other export opportunities for its APR1400 design and SMART SMR design. Korea is highly engaged with other countries for R&D, training and resource development. In 2011, it signed agreements with India and Saudi Arabia for nuclear energy cooperation covering joint work on R&D, design, construction, operation, maintenance and development of NPPs.

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 the commercial opportunities in the Republic of Korea, *contact:* Commercial Officer Kenton Chiang (Kenton.Chiang@trade.gov); SB Shin (Commercial Specialist in Seoul, sb.shin@trade.gov); I&A Civil Nuclear Team: Jonathan Chesebro (jonathan.chesebro@trade.gov)

For more information on nuclear energy in the ROK:

KEPCO website

<http://home.kepco.co.kr/kepco/EN/main.do>

Sources

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