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BEYOND FISSION: WHERE CHINA IS GETTING WITH SMALL MODULAR AND FUSION REACTORS

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On Oct. 13 of this year, the PRC state media outlet CPNN, reported that China is pulling ahead in advanced nuclear power technology development with the launch of the large-scale production "Hualong One" (also known as HPR1000). As it develops, China not only aims to tackle the transmission bottleneck in the south, but also to export to countries like Pakistan as the PRC's "business card" to the world.

China's dual goals of localization and export orientation have long defined its nuclear strategy. Led by state-owned giants such as the China National Nuclear Corporation (CNNC), Beijing has invested heavily in domestic innovation while aggressively expanding into overseas markets. Beijing has sought to expand its reactor sales to markets such as Argentina and the United Kingdom, while also securing control over upstream uranium resources. CNNC's 2019 acquisition of Namibia's Rössing Uranium Mine, one of the world's largest open-pit uranium operations, underscored China's growing dominance across the nuclear value. Beijing's policy support for state-owned enterprises has enabled it to build a vertically integrated nuclear industry, driving rapid advances in small modular reactors (SMRs), fourth-generation technologies, and nuclear fusion research (the Artificial Sun). Furthermore, intensifying US–China competition is reshaping global nuclear exports and deepening the geopolitical risks of dependence on Chinese nuclear systems.

From domestic reactors to global reach

Domestically, China has achieved a remarkable industrial build-out. Since adopting pressurized water reactor (PWR) technology in 1983 under the *Key Points of Nuclear Energy Development Policy*, China's nuclear roadmap has followed a three-step strategy: start with thermal reactors, advance to fast breeder reactors, and ultimately pursue nuclear fusion. The CNP-300, China's first domestically designed PWR, was the first unit completed in the 1990s and began operation at the Qinshan Phase I plant. This model later became China's first export reactor, installed at Pakistan's Chashma Nuclear Power Plant. Subsequent Qinshan projects, such as the CNP-600 and CNP-650, marked clear improvements in reactor capacity and design. The *National Nuclear Power Development Plan (2005–2020)*, approved by the State Council in 2003, formally set the course for transitioning from second- to third-generation reactors—spurring the development of the HPR1000 and advancing China's capabilities in both nuclear and conventional island design. China is now largely self-sufficient in reactor design and construction and is pursuing a closed nuclear fuel-cycle as part of its long-term strategy.

Meanwhile, CNNC's Linglong One (ACP100) SMR is the world's first land-based small modular reactor (SMR). The reactor began development back in 2010 as part of China's 12th Five-Year Plan for Energy Science and Technology Development (国家能源科技"十二五"规划) and became the first SMR to pass the final safety review by the International Atomic Energy Agency (IAEA) in 2016. The construction of the reactor started in 2021, and the equipment installation and reactor and outer containment dome building were completed in 2025. On Oct. 16 the reactor finished its first cold testing, confirming its proper installation, and is now scheduled to enter commercial operation in 2026.

Apart from the advancement in SMR deployment, China also demonstrates its capacity for building the fourth-generation nuclear reactor. The High Temperature Gas-Cooled Reactor (HTR-PM) constructed by China National Nuclear Corporation and China Huaneng Group in Shidao Bay is the world's first fourth-generation nuclear reactor to enter commercial operation. The reactor uses TRISO as fuel, which is enhanced to withstand higher temperatures and enables higher fuel efficiency. Due to the high temperature operation, it uses helium as a coolant. The self-development of the high-temperature gas-cooled reactor technology was initiated in the Medium- and Long-Term Plan for Science and Technology Development (国家中长期科学和技术发展规划纲要) published in 2006. In 2012, the reactor construction started, and it began commercial operation in 2023.

The success back home and IAEA approval of its technology encouraged China to expand its advanced reactor exports to new markets in Southeast Asian countries, in addition to Pakistan, Argentina, and the UK. China started to explore nuclear cooperation in Southeast Asia in 2015, when the China General Nuclear Power Group signed a cooperation agreement with the Association of Southeast Asian Nations to train nuclear professionals from its member countries. Since 2022, the China-ASEAN Forum on Peaceful Uses of Nuclear Technology has been held annually, and the focus has shifted from training and research cooperation to how China exports its technology and builds nuclear power plants in Southeast Asia. CNNC signed a Memorandum of Understanding (MOU) with the Indonesian National Research and Innovation Agency, and the Chinese government also signed MOUs with Thailand and Malaysia on nuclear power cooperation. SMRs are specifically mentioned in the Indonesian and Thai deals.

These developments reflect China's export strategy: rather than selling reactors piecemeal, Chinese firms offer turnkey packages — design, construction, fuel-cycle services, workforce training, and financing—underwritten by Chinese state-owned giants, signaling that ASEAN utilities could rely on Chinese training and regulatory support.

Harnessing nuclear fusion—The power of the sun

Nuclear fusion occurs when two light atomic nuclei, such as isotopes of hydrogen, combine under extreme temperature and pressure to form a heavier nucleus. While it releases vast amounts of energy, it produces minimal radioactive waste and no carbon emissions, making it a potential source of nearly limitless clean energy. To date, no countries are able to achieve such technology but a fusion arms race has long begun and intensified since the US reached net fusion energy at the National Ignition Facility at Lawrence Livermore National Laboratory in 2022.

In China, Beijing sees fusion as a central pillar of its future energy mix and as a means to reduce dependence on fossil-fuel imports. By the mid-2030s China plans to operate pilot fusion reactors, with the ultimate ambition of a commercial fusion power plant by 2050, though some PRC experts caution that full deployment may not arrive before 2060. China's engagement in the international ITER project, where PRC staff account for approximately 9.4% of all personnel.

This global collaboration has spurred major domestic advances. For example, in January 2025 the Experimental Advanced Superconducting Tokamak (EAST), China's so-called "Artificial Sun," achieved steady-state high-confinement plasma for 1,066 seconds, far surpassing its prior record of 403 seconds. In March 2025 the HL-3 Tokamak reactor in Chengdu achieved ion temperatures of 117 million °C and electron temperatures of 160 million °C—a "dual 100-million-degrees" milestone for the domestic fusion program. CNNC has recently assembled a major fusion innovation consortium involving more than two dozen state-owned companies, universities and research institutes.

The United States has taken increasing notice of China's rapid advances in fusion technology and the emerging global competition in the field. In response, Washington has intensified its support for the domestic fusion industry. The Department of Energy's Milestone-Based Fusion Development Program aims to accelerate progress toward pilot reactors by partnering with private firms, while the Nuclear Regulatory Commission is developing a streamlined licensing framework to facilitate commercial deployment. Leading U.S. companies such as Commonwealth Fusion Systems (CFS) and Helion Energy are at the forefront of this effort. For instance, CFS is pioneering the use of high-temperature superconducting magnets to achieve net energy gain, and Helion is pursuing a compact reactor design targeting a commercial demonstration by 2028 in collaboration with major technology partners.

Geopolitical and long-term dependency risks

As nations seek energy security, China is using reactor technology to expand its global influence. Backed by multi-year policy plans and powerful state-owned enterprises, it has advanced various nuclear reactor types and aspires to pioneer nuclear fusion—the "artificial sun." These ambitions alarm the U.S., which views nuclear exports as strategic assets and fears losing ground in the fusion race.

Buying reactors often creates decades-long dependence for maintenance and fuel, giving suppliers lasting leverage. Russia, for instance, ties its fuel supply to reactor sales. Similarly, China's growing strength in SMR technology raises concerns about supply chain and geopolitical risks. Without careful planning, countries may face long-term strategic vulnerability through reliance on foreign nuclear technology.

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