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南方能源观察

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全球核电升温

2025年2月8日 定价：人民币22元
ISSN 2221-6111

Energy Observer

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主管 **中国南方电网有限责任公司**
主办 **南方电网数字传媒科技有限公司**
出版 **《南方能源观察》杂志社有限公司**

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官方微博：weibo.com/eomagazine
国际标准连续出版物号：ISSN 2221-6111
国内统一连续出版物号：CN 44-1685/TK
出版日期：每月8日
定价：22元 总第255期
邮发代号：46-402
图片合作：视觉中国

Peru: A "New" Starting Point for Energy

By Han Xiaotong, Jiang Li

In November 2024, the Asia-Pacific Economic Cooperation (APEC) series meetings were held in Peru. This was the third time that Peru hosted this major event after 2008 and 2016.

In 2008, Peru initiated a bill to promote investment in renewable energy. After several years, how is the development progress of renewable energy in Peru?

Thanks to high proportions of hydro and natural gas power generations, Peru's energy and electricity system is relatively clean. However, the proportion of renewables such as wind and solar is relatively low. Under the combined influence of extreme weather and optimistic economic development expectations, some people believe that Peru's renewable sector holds promising prospects, and its energy transition will also offer new investment opportunities to Chinese energy enterprises.

Recently, Gustavo Adrianzén, Prime Minister of Peru, stated in an exclusive interview with a reporter from China Media Group in Lima, the capital of Peru, that Peru-China relations are currently at their best in history.

Peru is located in the central western coast of South America, bordered by Brazil and Bolivia to the east and the Pacific Ocean to the west. It is one of the most economically developed market economies in Latin America. China and Peru maintain close cooperative relations, with Peru being China's second-largest investment destination in Latin America, following Brazil.

In 2024, CSGI completed the acquisition of 83.15% of the shares in Pluz Energy Peru S.A.A. and 100% of the shares in Pluz Soluciones Peru S.A.C. This has marked the largest investment project by a Chinese enterprise in Peru over the past five years and represented the latest achievement in energy and power sector cooperation between China and Peru.

From 5% to 10%

According to the electricity report released by the Peruvian Ministry of Energy and Mines (MINEM), in March 2024, Peru's wind power generation reached 295 GWh, a year-on-year

increase of 152.8%; photovoltaic power generation reached 95 GWh, up 61.7% year-on-year. Including power generation from bagasse and biogas, non-hydro renewable energy accounted for 7.3% of Peru's total electricity generation.

Peru's "El Comercio" predicts that Peru's installed capacity of solar and wind energy would double in 2024, increasing its share in the country's energy mix from 5% to 10%.

In December 2023, the Economic Operation Committee of the National Interconnected System (COES) of Peru disclosed that 47% of the country's energy supply comes from hydropower, 46% from natural gas, with almost no coal power, and non-hydro renewables only accounting for 5.8%. According to statistics from the Latin American Energy Organization, the average share of non-hydro renewable energy in electricity generation in Latin America and the Caribbean is 13.3%, with Peru falling below this average.

Peru boasts abundant potential for wind and solar energy development. According to studies by MINEM and other institutions, the country has an estimated wind power potential of 20 GW and a solar power potential of 25 GW. Additionally, the southern region holds a geothermal power potential of 3 GW.

Several interviewees pointed out that one of the constraints on the development of renewable in Peru is the overall oversupply of electricity. Local media reports indicate that Peru's maximum power demand is approximately 8 GW, while the existing installed generation capacity stands at 13.6 GW. In recent years, the slowdown in Peru's GDP growth has also led to electricity demand increasing at a rate lower than expected.

There is also the view that, compared to many other countries, Peru already has a relatively clean energy and electricity system, which also means it might not have been fully motivated to drive the development of wind and solar power.

In terms of the policy, although Peru has set climate goals, it lacks a clear long-term energy matrix plan. In December 2020, the Peruvian High-Level Commission on Climate Change announced to the United Nations Framework Convention on Climate Change that Peru would become a carbon-neutral country by 2050.

As early as 2008, the Peruvian government enacted Decree Law No. 1002, the "Act on Investment Promotion for Electricity Generation Using Renewable Energies" (hereinafter referred to as "DL 1002"). DL 1002 introduced various measures and mechanisms such as biennial

auctions, subsidies, priority sales, and guaranteed grid connection to promote the development of renewable energy. However, many provisions of DL 1002 were not adhered to in the subsequent years.

A "new" starting point

After 2020, Peru's renewable sector underwent new changes.

In 2022, Peru's National Electricity Company spearheaded the development of the "Zero-Emission Energy Transition Roadmap for 2030-2050," aiming for renewable energy to account for 81% of the country's total electricity generation by 2030, with 35% of that coming from photovoltaic and wind power sources.

According to the latest information from MINEM, Peru has currently conducted feasibility studies for power generation projects with an estimated installed capacity of 5.885 GW. Among these, 64.7% are wind power projects, 13.2% are photovoltaic power projects, and 22.1% are hybrid wind-photovoltaic projects.

The COES's feasibility study projected that 22 GW of renewable energy projects in Peru will commence commercial operation between 2024 and 2029, 47% of which will come from wind power, 47% from solar energy, and 6% from hydropower. Non-hydro renewable energy sources are expected to dominate Peru's electricity growth.

Respondents generally hold an optimistic view of Peru's economic development, which also serves as a crucial foundation for its development in renewable.

According to the data from the National Institute of Statistics and Informatics (INEI) of Peru, in February 2024, Peru's gross domestic product (GDP) increased by 2.85% year-on-year, with the mining sector being among the best-performing industries.

Local media reported that the World Bank stated a 0.4% decline in 2023, while Peru's economic growth rate was expected to rebound to 2.5% in 2024 and reach 2.3% in 2025. Expanding the production of major copper mines will support its economic recovery, and increased mining output will continue to contribute to overall export growth.

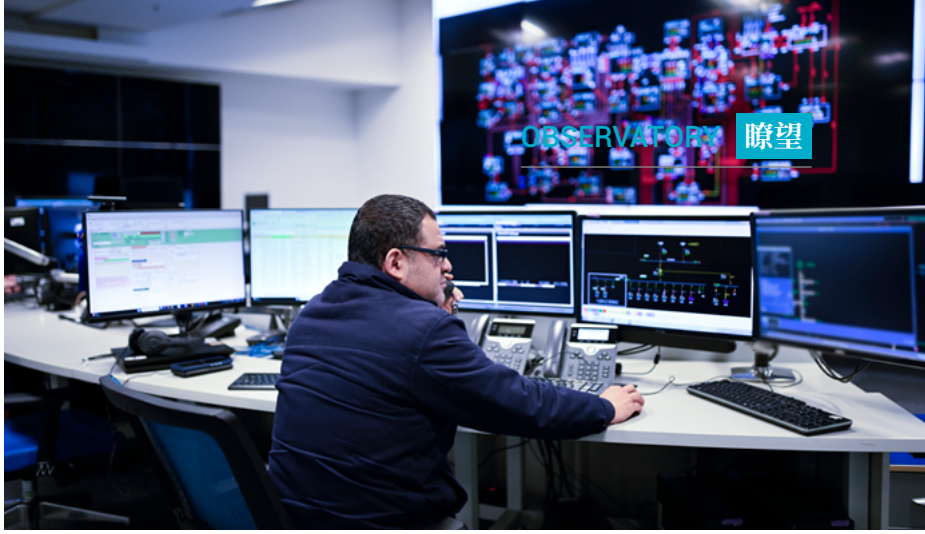
Peru is rich in mineral resources, ranking as one of the world's top 12 mineral-producing countries, with its total mineral output placing seventh globally. Notably, its copper reserves rank the second in the world.

Copper plays a significant role in the energy transition. In addition to wires and cables, wind turbines and solar panels also require substantial amounts of copper. The latest report from the International Energy Forum (IEF) indicates that the global energy transition will lead to a sharp increase in demand for copper ore, necessitating further intensification of mining efforts by countries worldwide. Additionally, there is a growing trend toward using renewable energy in copper mining operations.

Another driving force that accelerates Peru's renewable development is climate change. In recent years, influenced by the El Niño phenomenon, the flow and water levels of some rivers in Peru have been below average, and the water level of Lake Titicaca—the largest freshwater lake in South America, located at the border between Bolivia and Peru—has also seen a significant decline. COES revealed that Peru relies on diesel for power generation during water shortages, leading to increased electricity production costs.

One respondent noted that extreme weather events like El Niño posed increasing challenges to Peru's hydropower sector, and the inherent seasonal fluctuations of hydropower also made stable supply a challenge. "Having excess electricity during the wet season doesn't guarantee sufficient supply in the dry season."

The respondent believed that although Peru's proven natural gas reserves are sufficient to last for about 20 years, these reserves are ultimately finite and cannot be exploited indefinitely. "Currently, natural gas is sold to power generation companies



On October 12, 2024, local employees at the power dispatch control center of Peru's Boluz Energy Co., Ltd. carry out routine grid monitoring. (Source: CSGI)

at relatively low prices, but when the long-term supply agreements expire around 2030, it is not ruled out that gas prices may rise, and electricity prices would also be affected at that time," the respondent noted.

Several interviewees believed that there is room for the development of renewable in Peru, but the scale and speed of its growth still depend on the level of support from the local government.

China's "new" opportunities

Peru's regulatory agency OSINERGMIN believes that timely upgrades to the transmission system are crucial for the development of renewable energy. Currently, Peru's power grid lacks the capacity to fully integrate additional renewable energy sources, making urgent upgrades and renovations necessary.

Several interviewees noted that renewable energy power plants in Peru are typically built in remote areas. The Peruvian government has now begun to conduct regular studies on the transmission needs required to enhance the quality, reliability, and safety of renewable energy supply, and is preparing to develop transmission planning based on these findings.

Currently, the main market player in Peru's power transmission system is the Colombian National Transmission Company (ISA). ISA is also the largest transmission company in Latin America. According to the 2023 annual report published on the ISA official website, ISA Peru operates primarily nine 220 kV transmission lines, six 138 kV transmission lines, and 11 substations at various voltage levels in Peru.

More than one interviewee mentioned that although ISA Peru holds a dominant position in the transmission sector within the country, Chinese energy companies still have opportunities. On one hand, local energy regulators in Peru aim to enhance market diversity and prevent ISA Peru from monopolizing the market. On the other hand, China's high-voltage direct current (HVDC) transmission technology offers a competitive advantage.

"In the future, Peru will continually present new opportunities for greenfield power transmission projects, as well as secondary transmission projects with voltage levels between transmission and distribution, which Chinese companies can focus on," said one interviewee.

Another respondent believed that Chinese companies possess advanced technological advantages and, in addition to investment, Chinese companies should also seek more opportunities in EPC projects.

With the energy transition driving the development of distributed renewable energy, there will be more investment opportunities for upgrading and transforming distribution grids in the future. Several interviewees also noted that if renewable energy accelerates its growth, Peru will need to further develop energy storage to address the volatility and intermittency of wind and solar power. They are calling on the Peruvian government to promptly introduce corresponding regulations and adjust the current regulatory framework to allow energy storage into the electricity market.

Nuclear Power Revival: Trends and New Options

By Liu Wenhui, He Nuoshu

▲ The "Hualong One" unit at Fujian Fuqing Nuclear Power Plant. (Source: Visual China Group)

Nuclear power, once controversial due to safety concerns like the Fukushima accident and experiencing a development standstill, has regained momentum as a viable energy option for many countries in response to energy security demands.

Relying on their technological strength, traditional nuclear power countries maintain their status as the possessors of the new generation of nuclear power technologies, while China has quietly joined their ranks, preparing to participate in the global market. The extension of reactor lifespans ensures that nuclear power continues to play a significant role in clean electricity supply across many countries, with clear advantages in electricity pricing. Nations that had considered abandoning nuclear power are now reconsidering, reintegrating it into their list of energy options.

In the renewable structure, nuclear power needs to adapt to more diverse scenarios and provide a broader range of services, with nuclear heating and steam supply, as well as small reactors powering data centers, emerging as new utilization trends. Under the new global circumstances, Europe and the United States are consolidating their nuclear fuel supply chains, reshaping the global nuclear fuel supply landscape. Within the current industry dynamics, nuclear power still faces numerous challenges in terms of site selection, technology, and regulations. Countries that reconsider to use nuclear power need to dispel safety concerns first, and nuclear power cooperation in emerging nuclear power markets is often deadlocked due to costs.

A new wave of nuclear power industry revival is arriving.

Global nuclear power revives

Globally, large-scale units remain the mainstream of nuclear power plants under construction.

After the Fukushima nuclear accident,

traditional nuclear power countries such as the United States, France, and Russia gradually resumed the construction of large-scale commercial nuclear power projects after safety inspections. The technologies employed were all independently developed third-generation nuclear power, but the scale of construction was limited. Most nuclear power units in the United States were built in the 1970s and 1980s, with 94 units contributing nearly one-fifth of the total electricity generation, accounting for half of the clean power. Due to the extended lifespan of nuclear power units and the cost-effectiveness of natural gas power generation over the past two decades, the construction of new large nuclear power units does not align with the demands of the US market. In fact, some nuclear power units have been shut down prematurely for operational reasons.

France currently has 57 operational nuclear power units, with nuclear energy accounting for 62% of its electricity generation, making it the world's largest net exporter of electricity. Following the grid connection of the Flaman Ville 3 unit, which employs France's independently developed third generation EPR nuclear technology, there are no nuclear power units currently under construction in the country. However, plans for new nuclear power units have been incorporated into the government's agenda.

Russia, a major oil and gas power, operates a total of 36 nuclear power units, contributing approximately 19% of its electricity generation, with 6 new units currently under construction.

For the United States, France, and Russia, expanding the overseas nuclear power market has always been a crucial pillar for the development of their nuclear power industries.

China is a destination for these traditional nuclear power nations to expand their nuclear projects. Both the US AP1000 technology and the French EPR technology have seen their first global reactors built in China, while Russian VVER units are currently constructing in the Tianwan Nuclear Power Plant and the Xudapu Nuclear Power Plant. After achieving self-sufficiency in third-generation nuclear power technology, the Chinese market has also robustly supported the scaled development of domestic nuclear power. Currently, China has 26 large-scale reactors under construction, far exceeding the numbers in other countries.

The latest data released by the National Energy Administration (NEA) shows that as of 2024, China's installed capacity of operational and approved under-construction nuclear power units has reached approximately 113 million kilowatts, ranking first in the world. In 2025, China will approve and commence construction on a batch of mature coastal nuclear power projects while steadily advancing the ongoing nuclear power projects.

Within the EU, the debate over whether nuclear power qualifies as green energy has never ceased, yet the pace of nuclear power construction by its supporting nations has not slowed down. In these markets, the technological approaches of the United States and France have more advantages.

In Africa, Egypt is constructing four nuclear power units using Russian VVER technology, while Ghana is tendering for suppliers for its first large-scale nuclear power plant. Having joined the ranks of nuclear power giants, China is actively expanding into overseas markets. China National Nuclear Corporation is participating in Ghana's first large-scale nuclear power plant project, competing with other bidders such as Électricité de France and Rosatom.

Japan's policy on nuclear power is also undergoing changes. After the Fukushima nuclear accident, Japan's policy initially leaned towards minimizing reliance on nuclear energy as much as possible, seeking development in areas such as natural gas power generation and hydrogen energy utilization. However, after encountering issues like power shortages, nuclear energy has

gradually returned to the center stage of policy. With approximately 10% of natural gas imported from Russia, the Russia-Ukraine conflict has also become a significant reason for the Japanese government's shift back to nuclear energy.

Recently, Japan's Ministry of Economy, Trade and Industry drafted a revision to its renewable plan, no longer declaring a reduction in reliance on nuclear power while proposing an increase in the replacement of decommissioned units. The revised draft indicates that Japan will strive to ensure that the operators of decommissioned nuclear power plants replace the existing ones with new-generation reactor technologies.

SMRs gain global favor

In an energy mix where the share of renewables is surging, large nuclear power units are constrained by power regulation and site limitations. Small Modular Reactors (SMRs) demonstrate greater flexibility and can adapt to a wider range of application scenarios, making them a key development focus for some traditional nuclear power countries.

Nuclear power may be the only issue in the United States that enjoys bipartisan support. In 2019, the United States enacted the Nuclear Energy Innovation and Modernization Act (NEIMA), and in July 2024, it passed the Advanced Nuclear for Clean Energy (ADVANCE) Act, which provides guidelines for SMRs aimed at improving the efficiency of the review process, thereby strongly promoting the implementation of SMR projects in the country.

In 2023, NRC approved the first SMR design—the 50 MW advanced light-water reactor from Nuclear Power. The first project featuring six modules is located at the Idaho National Laboratory in the United States, with operations potentially starting as early as 2026. In May 2024, Terra Power, founded by Bill Gates, had its construction permit application for the Natrium sodium-cooled fast reactor officially accepted by the NRC. Kairos Power's 70 MWt Hermes 2 power plant received its construction license in November 2024 and will build two 35 MWt molten salt reactors.

With Donald Trump returning to office, personnel appointments in the US energy sector have drawn widespread attention. Recently, Trump announced the appointment of David Wright as Chairman of the NRC and Mark Christie as Chairman of the Federal Energy Regulatory Commission (FERC). The personnel arrangements and policy orientations of these two agencies will, to some extent, influence the direction of US nuclear energy policy. Notably, Mark Christie, who is set to become Chairman of FERC, is not only a supporter of fossil fuels but also a long-time advocate for nuclear energy.

In 2021, the United Kingdom opened the Generic Design Assessment (GDA) application for SMRs. In 2022, GE Hitachi Nuclear Energy (GEH) submitted a GDA application for the BWRX-300 SMR, which passed the first phase of assessment in December 2024. China's first commercial SMR demonstration project, the Linglong Number One, located in Changjiang, Hainan. The nuclear island construction began in July 2021, making it the world's first small modular commercial pressurized water reactor unit to commence construction. According to the National Nuclear Safety Administration of the People's Republic of China, the Linglong Number One SMR features an integrated core module structure and employs a newly designed reactor coolant main pump, placing higher demands on the independent R&D and manufacturing capabilities of China's main pump suppliers.

In South America, Argentina initiated the construction of the CAREM-25 SMR project as early as 2014. However, the project was not progressing smoothly, and its future remains uncertain. In 2024, media reports indicated that Argentina has formulated new plans for SMR development, proposing to build an SMR next to the existing Atucha Nuclear Power Plant using domestically developed technology.

Fangchenggang Hualong One. (Source: Visual China Group)

Clean and ensuring energy security and independence have always been key reasons for supporting nuclear power. In Europe, the soaring energy prices in recent years have further bolstered the case for nuclear energy, prompting a shift in attitude in many countries. Consequently, SMRs, representing the emerging trend in nuclear development, have become a preferred option.

Recently, Norway-based Norsk Kjernekraft submitted a proposal to the Norwegian Ministry of Energy, requesting an assessment for the construction of a SMR nuclear power plant in western Bergen. According to reports, the proposed site could accommodate five 300MWe-class SMRs, with an annual electricity generation capacity of 12.5 terawatt-hours, equivalent to nearly 10% of Norway's current total electricity consumption. Norway had opted to phase out nuclear power in the 1970s. However, in recent years, rising electricity prices triggered by shifts in the energy supply landscape have led the country to reassess its stance on nuclear energy. To ensure energy security and price stability, nuclear power is once again being considered as part of the national energy strategy. As a key energy supplier in Europe, Norway plays a significant role in stabilizing the European energy market. Currently, some private enterprises and local governments in Norway are exploring collaboration opportunities to develop SMRs.

The Italian government has officially initiated an assessment of the feasibility of restarting nuclear power, with the strategic focus directed towards new nuclear technologies, particularly the development of SMRs. Although Italy once phased out nuclear power, the country still retains certain capabilities in nuclear power operation and research. Its state-controlled utility company, Enel, operates nuclear power projects in Spain, while Edison, the Italian subsidiary of France's EDF, is also engaged in the development of SMRs.

In 2011, the Fukushima nuclear accident led to a cooling-off period for the global nuclear power industry. More than a decade later, energy security concerns arising from geopolitical tensions such as the Russia-Ukraine conflict have prompted countries to reassess the role of nuclear power. Judging by the swift policy and industrial responses of various parties, traditional nuclear power giants have never left the stage. Despite a slowdown in domestic nuclear construction, their global market presence has kept their technological capabilities intact, and the extension of reactor lifespans has ensured that nuclear power continues to account for a significant share of electricity generation in many countries.

DeepSeek Arrives: Is Power No Longer a Bottleneck for AI Development?

By Jiang Li

During the Chinese Lunar New Year, I asked DeepSeek a question: Compared to GPT-4, how much computing power can you save? Below is an excerpt from part of DeepSeek's response:

There is currently no official publicly available detailed data, but reasonable inferences can be made based on the model architecture and known information:

Model Scale Optimization: GPT-4 has approximately 1.8 trillion parameters (estimated) and employs a Mixture of Experts (MoE) architecture, with training consuming around 2.15e25 FLOPs. The models publicly released by DeepSeek (such as DeepSeek-R1) have significantly fewer parameters (around the billion scale). Through sparse activation and architectural optimization, efficient computation is achieved, theoretically reducing training computational requirements by 1-2 orders of magnitude.

Real-world Performance Difference: In comparable tasks, DeepSeek's achieves inference speed 3–5 times faster than that of GPT-4 (based on some public test data), with approximately 60% less GPU memory usage.

According to data from Visual Capitalist, as of March 2024, the United States has 5,381 data centers, ranking first in the world. Germany, the United Kingdom, and China each has around 500, with 521, 514, and 449 respectively. In 2024, American tech companies are still scrambling for electricity everywhere.

As the development of generative AI technology enters a period of explosive growth, its surging power demands are placing immense

Night View of CGS Guangzhou Substation Science Center Building

pressure on the US power grid. A Bloomberg report previously cited by Energy Observer indicated that over three-quarters of highly distorted power readings in the United States are within 50 miles of large data center activity, suggesting that these centers may be causing harmonic issues that could disrupt the stable operation of the power system.

In September 2024, executives from multiple tech companies, including NVIDIA and Google, visited the White House and proposed the idea of government funding for energy facilities to support the training of top-tier AI models. They suggested building several massive data centers, each with power demands comparable to the entire electricity consumption of New York City.

In addition to seeking government support to develop data centers as a means of powering the growth of generative AI large models, these companies are also turning their attention to nuclear power—a power source that relatively matches the needs of data centers. Meanwhile, they are attempting to invest in emerging nuclear technologies, making nuclear power giants such as Constellation Energy and some startups such as Oklo highly sought-after partners.

This new and immense surge in energy demand once led some in the power industry to believe that a transformation was coming. However, the emergence of DeepSeek may upend these early assumptions. Through more efficient computing, DeepSeek's computational power requirements have sharply decreased compared to OpenAI. Distributed deployment of computing power, where everyone could have their own DeepSeek, has become one of the options. AI might no longer be an energy-hungry "behemoth."

However, an article published on the MIT Technology Review website mentioned that in a test of 40 prompts, DeepSeek was found to have similar energy efficiency to the Meta model, but DeepSeek tended to generate longer responses and therefore was found to use 87% more energy usage. That said, as different models serve different purposes, there is still a lack of rigorous, scientifically grounded comparisons regarding DeepSeek's energy performance relative to its competitors.

The continuous evolution of AI technology has also spurred the development of embodied intelligent manufacturing, which may become one of the key drivers of future electricity demand growth. In my view, since cooling often consumes a significant amount of electricity, data centers in the future are more likely to be deployed in relatively cooler locations to reduce air conditioning load. Additionally, as user demand for green electricity consumption gradually increases, integrated hydro (storage), wind, solar, or nuclear power will become preferred options.

From DeepSeek's perspective, AI-driven collaborative optimization will be one of the technical supports and innovative directions for the synergy between computing and electricity. This involves using AI models to simultaneously optimize computing resource allocation and power scheduling. For example, task migration shifts high-power-consuming computing tasks to periods with abundant green electricity; while dynamic frequency reduction lowers server frequencies during power shortages to reduce power consumption.

Summary from Deepseek:

The synergy between electricity and computing power is not just a technical issue but also a systemic project involving economics, policy, and ecology, which will become the core intersection of global carbon neutrality and digital transformation.