

NUCLEAR ENERGY IN PAKISTAN: PROSPECTS AND CHALLENGES

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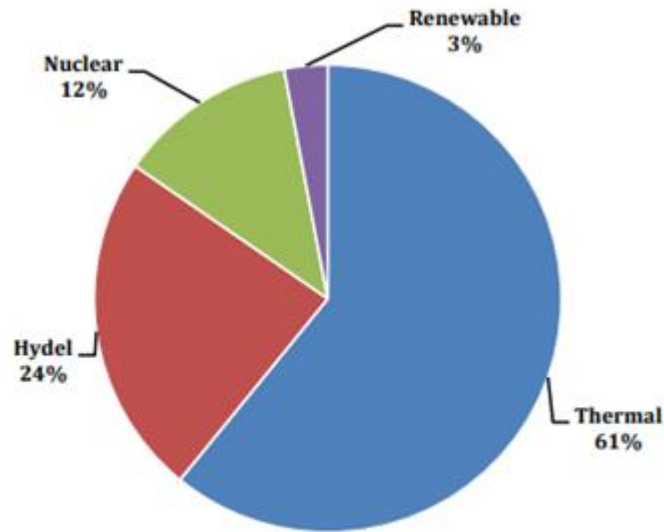
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Two critical events have brought into focus the need for clean and green energy sources. The first is the Ukraine conflict and the energy crunch that the world is facing as a result. The second is the catastrophic consequences of Climate Change that Pakistan has faced in the form of floods in the last few months whereby a third of Pakistan is under water and more than 33 million people have been affected. Pakistan is one of the countries responsible for 0.4 per cent of global carbon emissions but is ranked as the eighth most vulnerable to Climate Change. Nuclear power is a relatively cheap, renewable energy source that produces very little carbon emissions. Nuclear power is 9.8 per cent of the global energy mix. In recent years, there has been a resurgence in developing the nuclear energy sector globally. Pakistan is also working to increase its share of nuclear energy in the total energy mix. Other power generation sources in Pakistan are hydro, thermal, natural gas, coal, wind and solar. Presently Pakistan's nuclear energy in the overall mix is 12 per cent. Nuclear power has the potential to contribute more to the national grid if it is invested in. Given current Climate Change challenges, it is pertinent to carry out an appraisal of nuclear energy in Pakistan. It is important to assess how many nuclear power plants Pakistan operates and has under construction, as well as its nuclear energy outlook in the coming decades.

Pakistan: Share in Energy Mix



Source: Ministry of Energy, (Power Division)

Currently, Pakistan has six nuclear power plants operational. In March 2022, the K-3 Unit of the Karachi Nuclear Power Plant with 1100 MW capacity was connected to the national grid. It was the second overseas nuclear power unit to use China's third-generation nuclear reactor technology Hualong One. Construction of K-3 began in May 2016 while K-2 started production in May 2021, which was the first export of China National Nuclear Corporation (CNNC's) Hualong One or HPR1000.¹

Each Hualong One reactor can produce 10 billion kWh of electricity annually which is enough for the electricity requirement of 4 million households in Pakistan. Energy generation is equivalent to reducing coal use by 3.12 million tons annually while preventing the emission of 8.16 million tons of carbon dioxide every year. Besides meeting the energy needs of Pakistan the K-2 and K-3 have provided more than 10,000 jobs directly and created more than 40,000 jobs indirectly through the industrial chain.²

Pakistan is already operating four CNP-300 pressurized water reactors (C-1, C-2, C-3 and C-4) at Chashma in Punjab. In 2017, China signed a cooperation agreement with the Pakistan Atomic Energy Commission (PAEC) on the construction of a Hualong One as a fifth unit at Chashma or C-5. In September 2021, another agreement was signed between PAEC and China Zhengyuan Engineering

¹ "Karachi 3 begins Supplying Electricity," *World Nuclear News*, March 7, 2022, <https://www.world-nuclear-news.org/Articles/Karachi-3-begins-supplying-electricity>.

² Ibid.

Cooperation to deepen the nuclear energy cooperation, build, and uphold Pakistan's nuclear power projects.

Nuclear Power in Pakistan

Reactor Name	Alternative Name	Model	Reactor Type	Net Capacity (MWe)	Construction Start	First Grid Connection
CHASNUPP-1	Chashma Nuclear Power Plant 1	CNP-300	PWR	300	1993-08	2000-06
CHASNUPP-2	Chashma Nuclear Power Plant 2	CNP-300	PWR	300	2005-12	2011-03
Chashma Nuclear Power Plant Unit 3	Chashma Nuclear Power Plant 3	CNP-300	PWR	315	2011-05	2016-10
Chashma Nuclear Power Plant Unit 4	Chashma Nuclear Power Plant 4	CNP-300	PWR	313	2011-12	2017-06
K-2	Karachi 2	HPR1000	PWR	1,014	2015-08	2021-03
K-3	Karachi 3	HPR1000	PWR	1,014	2016-05	2022-03

Source: "Nuclear Power in Pakistan," updated March 2022, <https://world-nuclear.org/information-library/country-profiles/countries-o-s/pakistan.aspx>.

The gross capacity of these nuclear power plants was 2,530 MW, which supplied about 7,076 million units of electricity to the national grid in the period July-March 2020-21. The capacity of these nuclear power plants has increased since and stands at 3530 MW, which supplied 12,885 million of electricity to the National grid from July 1, 2021, to March 31, 2022. This is an increase of 39 per cent in terms of MW and an 82 per cent increase in terms of units supplied. The six NPPs performed effectively even in difficult times like the COVID-19 pandemic and provided uninterrupted power supply at the highest capacity factors. K-2 has made a new record in Pakistan's history by operating for 100 days continuously since its commercial operation date. It became the first nuclear power plant to achieve this milestone.³

Table 14.5: Performance of Nuclear Power Plants

Plant	Capacity (MW)		Electricity sent to Grid (million kWh)	
	Gross	Net	FY2021-2022 July-March	Lifetime up to March 2022
KANUPP*	100	90	45	14,972
C-1	325	300	1,861	43,919
C-2	325	300	1,779	24,709
C-3	340	315	1,681	12,716
C-4	340	315	1,500	10,539
K-2	1,100	1,017	5,874	6,887
K-3	1,100	1,017	145	145

* KANUPP permanently shut down for decommissioning on August 01, 2021

Source: Pakistan Atomic Energy Commission

³ "Energy," Pakistan Economic Survey, 2021-2022, P.266.

Pakistan is trying to enhance the role of nuclear energy and renewable energy sources in the overall energy combination to overcome the energy crisis and for overall socio-economic development in the country. Pakistan aims to generate 8,800 MW of nuclear power by 2030. Pakistan envisages a nuclear power generation capacity of 40,000 MW under its Nuclear Energy Vision 2050. Pakistan has selected eight more sites with four nuclear power plants each, with a planned total of 32 NPPs that would provide 25 per cent of the country's energy requirements by 2050.⁴ These sites include the Qadirabad-Bulloki (QB) link canal near Qadirabad Headworks; Dera Ghazi Khan canal near Taunsa Barrage; Taunsa-Panjanad canal near Multan; Nara canal near Sukkur; Pat Feeder canal near Guddu and Kabul River near Nowshera. To keep us with future nuclear energy requirements the PAEC has plans to improve the existing nuclear infrastructure and human resources. It also has plans puts to promote nuclear technology indigenisation that will reduce import dependence and subsequent nuclear power costs.⁵

Challenges

There are several challenges to expanding nuclear energy in Pakistan. International cooperation over nuclear energy is limited and restricted due to fears of nuclear materials diversion from civil use. Pakistan is not part of the export control group Nuclear Suppliers Group (NSG) nor is India since they are not signatories of the Nuclear Non-Proliferation Treaty (NPT). While NSG granted a waiver to India for civil nuclear cooperation with several countries, there are discriminatory policies towards Pakistan that are kept out of civil nuclear cooperation. China has been the only partner country that has helped Pakistan construct nuclear power plants. The irony in all this is that Pakistan has had an impeccable nuclear safety and security record in almost six decades of nuclear power generation while India has a history of nuclear safety and security lapses and dozens of incidents of nuclear theft.⁶ Additionally, Pakistan has taken measures to strengthen protections against theft or accident. Pakistan has already improved by 25 points on the Nuclear Security Index (NTI) in terms of the security of its nuclear materials as per 2020 rankings. It is a ranking maintained by Nuclear Threat

⁴ "Pakistan Plans 40,000MW Nuclear Energy by 2050 to meet Electricity Demands," *Gulf News*, February 26, 2022, <https://gulfnews.com/world/asia/pakistan/pakistan-plans-40000mw-nuclear-energy-by-2050-to-meet-electricity-demands-1.86031513> .

⁵ "Pakistan: Country Nuclear Power Profiles," Updated 2022, <https://cnpp.iaea.org/countryprofiles/Pakistan/Pakistan.htm>

⁶ Ghazala Yasmin Jalil, "The Myth of India's Impeccable Non-Proliferation Record," Issue Brief, Institute of Strategic Studies Islamabad, May 31, 2021, https://issi.org.pk/wp-content/uploads/2021/05/Final_IB_Ghazala_May_31_2021.pdf and Malik Qasim Mustafa and Ghazala Yasmin Jalil, *Pakistan and India: Non-Proliferation Credentials*, Nuclear Paper Series No. 2, Islamabad Papers 2016, Institute of Strategic Studies Islamabad.

Initiatives on countries' security and control indicators.⁷ In addition, Pakistan has placed all its research and power reactors under International Atomic Energy Agency safeguards while India has not. Reportedly, there are efforts to develop a nuclear fuel complex that will separate the civilian and military fuel cycle, which is a frequent objection to international cooperation with Pakistan.

Conclusion

Pakistan has the goal of achieving zero carbon emissions for the energy sector by 2050. Pakistan's vision to supply one-fourth of its energy needs through nuclear power by 2050 will go a long way in achieving this goal. Nuclear power has the potential to contribute more to the national grid if it is invested in. However, a lack of financial resources and an unwillingness of countries to engage in civil nuclear cooperation are hindering this goal. Export control cartels like the NSG need to have a criteria-based approach towards civil nuclear cooperation and need to abandon double standards. Pakistan-China civil nuclear cooperation has helped achieve the development of Pakistan's nuclear energy sector. Their cooperation in civil nuclear technology is not only helping achieve UN sustainable development goals (UNSDGs) but also contributing to socio-economic development in the country. The promotion of peaceful nuclear technology increasingly plays an important role in national development but will also help fight the scourge of Climate Change. Pakistan has taken the brunt of the adverse effects of Climate Change with the immense damage caused by the recent floods. The world needs to unite in fighting Climate Change and take the lead in mitigating carbon emissions. The promotion of nuclear energy globally and in Pakistan is a step in the right direction to achieving climate security.

⁷ "Australia Ranks 1st, Pakistan is most improved," NTI, <https://www.ntiindex.org/news/australia-ranks-1st-pakistan-is-most-improved/>.