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Nuclear Energy to Combat Climate Change for Developing Countries

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Key Points:

- Nuclear energy is a low-carbon and sustainable energy source. However, due to the military applications of nuclear technology, it has become a political issue and its true potential has not been achieved.
- The responsibility for the current levels of carbon footprint in the atmosphere lies mainly with the developed countries. But the severity of the threat is faced by the developing and underdeveloped countries, where the resources to mitigate the effects of climate change are limited.
- While strong regulatory and control measures are essential for nuclear technologies' handling, they have also become the subject of geopolitics. The development of nuclear energy faces political issues more than economic and technical issues.
- Developing countries lack the expertise, technologies, and resources to develop nuclear power to meet their growing national demands without the help and political support of developed countries.
- Pakistan plans to have 11 nuclear power plants with 8900-megawatt capacity by 2030, and 32 plants with 44000-megawatt capacity by 2050, thereby increasing the share of nuclear power to one-fourth of total electricity produced nationally.
- Apart from increasing the allocation of more resources to tackle climate change, developed countries can come forward to help developing countries prevent and mitigate climate threats by promoting nuclear power in those countries. More than 30 countries are planning to develop nuclear power but face a range of challenges.
- Developed countries and international institutions like the IAEA can stimulate the developing states' plans for nuclear power. Employing advanced nuclear reactor designs with improved safety, plugging gaps in the proliferation regime, effective radioactive waste management and further cost reduction for constructing nuclear power plants can be intrinsic steps that can be taken.

Introduction

Climate change is perhaps the most serious non-traditional threat for human survival on earth. At the same time, humanity is confronted by the dilemma of growing demand for energy and continued reliance on fossil fuels for economic development. While renewable energy sources are growing, they also have limitations. Nuclear energy, on the other hand, is a low-carbon

and sustainable energy source. However, due to the military applications of nuclear technology, it has become a political issue, and its true potential has not been achieved. While it is true that the development of nuclear power plants requires stringent safety and security measures, the political aspects of the issues also merit attention.

The responsibility for the current levels of carbon footprint in the atmosphere lies mainly with the developed countries. But the severity of the threat is faced by the developing countries, more so by the underdeveloped countries where the resources to

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mitigate the effects of climate change are limited. This calls for the developed countries to increase their efforts to mitigate the effects of climate change. Furthermore, developed countries hold the key to the increasing role of nuclear energy since the developing countries cannot build nuclear power plants on their own.

Climate Change and Role of Energy

Energy production from fossil fuels is one of the largest sources of the increasing carbon emissions in the atmosphere. Greenhouse gases (GHGs), such as carbon dioxide, methane, and nitrous oxide, cause global warming by trapping heat inside the atmosphere. The global average temperature has increased by 1.1 degrees Celsius since 1880.¹ It is predicted to increase further, which will cause sea-level rise, extreme weather patterns, floods, droughts, human migrations, and global food shortages. Besides increasing the carbon footprint, fossil fuels also add to water, air, and thermal pollution. According to the Intergovernmental Panel on Climate Change (IPCC), fossil fuels-produced emissions are among the predominant causes of global warming. In 2018 only, fossil fuels caused 89 per cent of global CO₂ emissions.²

In the United States (US) alone, the second-largest source of GHG emissions is the energy production sector, with a total share of 25 per cent in 2020. The transportation sector remained the largest source, with a 27 per cent share primarily due to the burning of fossil fuels for moving the wheels on roads.³

The share of fossil fuels for energy is also consistent despite the growing awareness about its share in the emission of GHGs. Currently, fossil fuels comprise around 80 per cent of the world's energy supply.⁴

Nuclear Energy: A Better Alternative

According to the International Energy Agency (IEA), nuclear energy remains the most substantive low-carbon source of electricity. It is a sustainable source of electricity due to 24/7 uninterrupted electricity production, unlike wind and solar, which are dependent on geographical conditions. The per-unit cost of nuclear energy is also relatively cheap though the upfront cost

¹ "Global Temperature," NASA, accessed May 25, 2022, <https://earthobservatory.nasa.gov/world-of-change/global-temperatures>.

² "Fossil fuels and climate change: the facts," *Client Earth*, February 18, 2022, <https://www.clientearth.org/latest/latest-updates/stories/fossil-fuels-and-climate-change-the-facts/>.

³ "Sources of Greenhouse Gas Emissions," *United States Environmental Protection Agency*, accessed May 25, 2022, <https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions>.

⁴ "What Is the Energy Mix?" *Planète Énergies*, October 19, 2021 <https://www.planete-energies.com/en/medias/close/what-energy-mix>.

of the development of nuclear power plants remains high. However, renewable energy sources also have higher upfront costs.⁵

Nuclear power plants also produce electricity at a higher capacity factor of above 90 per cent, unlike other sources.⁶ Due to the high-capacity factor of nuclear power plants, they can replace more than one coal-based power plant to generate the same amount of electricity. Two coal-based power plants working on 40-50 per cent capacity factor can be replaced with one nuclear plant operating at up to 90 per cent capacity factor.

However, there are some downsides to nuclear energy too. Nuclear energy produces extremely harmful radioactive material and radioactive waste. The problem is being solved with the development of effective storage and disposal measures. Due to the sensitivity of the nuclear materials, their safety and security concerns are also a major challenge. Furthermore, nuclear technologies are also available from a limited number of countries. While strong regulatory and control measures are essential for nuclear technologies' handling, they have also become the subject of geopolitics. The development of nuclear energy faces political issues more than economic and technical issues.⁷

Current Electricity Mix and Scope of Nuclear Energy

Global electricity demand continues to increase due to changing lifestyles, growth in population, increasing dependence on electronics, economic growth, and harsh weather patterns.

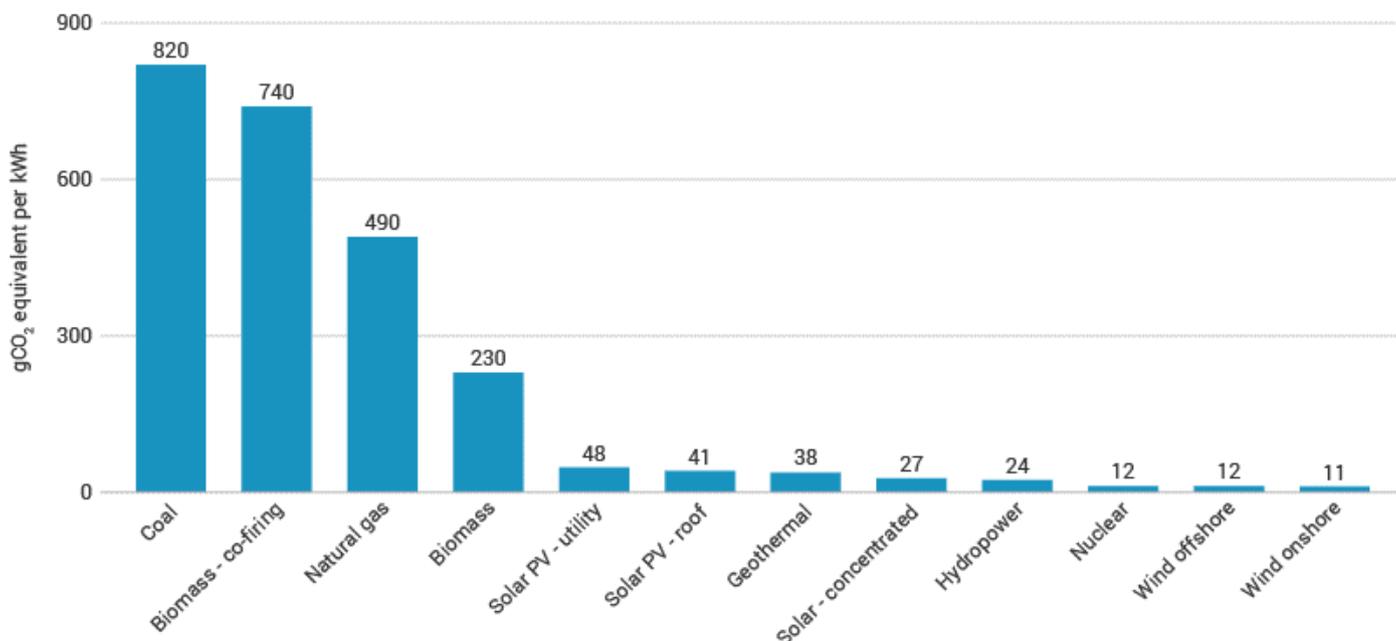
Coal and natural gas remain the largest sources of electricity production with a share of 36 per cent and 23 per cent, respectively. Nuclear and renewables account for more than one-third (36.7 per cent) of global electricity production.⁸ Out of this, the nuclear sector accounts for only 10 per cent of electricity production. Other renewables like wind and solar are promising, and their share in the energy supply is growing. However, they face several issues like limited

⁵ Laszlo Varro and Peter Fraser, "The Covid-19 crisis is undermining nuclear power's important role in clean energy transitions," *IEA*, June 12, 2020 <https://www.iea.org/commentaries/the-covid-19-crisis-is-undermining-nuclear-power-s-important-role-in-clean-energy-transitions>.

⁶ "What is Generation Capacity?" *Office of Nuclear Energy*, May 1, 2022, <https://www.energy.gov/ne/articles/what-generation-capacity>.

⁷ Michal Onderco and Darren McCauley, "Going nuclear? The long-term problem is political," *Clingendael Spectator*, January 28, 2021, <https://spectator.clingendael.org/en/publication/going-nuclear-long-term-problem-political>.

⁸ Hannah Ritchie and Max Roser, "Electricity Mix," *OurWorldInData.org*, accessed May 2, 2022, <https://ourworldindata.org/electricity-mix>.



Average life-cycle carbon dioxide-equivalent emissions for different electricity generators (Source: IPCC)

power generation capacity, weather dependence, and high costs.

Trends over the past few years show that the share of other renewables has grown, and the share of coal and gas has remained constant.⁹ In comparison, the share of nuclear energy has reduced from 15.13 per cent in 2005 to 9.94 per cent in 2021.¹⁰ These trends indicate the unabating global dependence on fossil fuels for meeting the growing energy or electricity demand. The share of nuclear energy keeps getting smaller despite it being an environmentally friendly alternative to fossil fuels.

The gap between electricity generation from renewables and overall global electricity demand is also widening, pushing countries to generate more electricity from fossil fuels. According to a report by IEA, electricity demand rose by 5 per cent in 2021, and half of this demand was met by generating electricity from fossils such as coal.¹¹ So why is the world not building more nuclear power plants but continuing to depend on coal and gas? The problem mainly lies in the sensitive and political nature of nuclear technology.

The potential of nuclear power to meet the electricity

⁹ "Electricity production by source, World," *Our World in Data*, accessed May 25, 2022, <https://ourworldindata.org/grapher/electricity-production-source-stacked?stackMode=relative>.

¹⁰ Ibid.

¹¹ "Global electricity demand is growing faster than renewables, driving strong increase in generation from fossil fuels," *International Energy Agency*, July 15, 2021, <https://www.iea.org/news/global-electricity-demand-is-growing-faster-than-renewables-driving-strong-increase-in-generation-from-fossil-fuels>.

demand of the world for the next couple of decades is extremely promising. According to various studies, nuclear power promises to remain an environmentally benign way of electricity production.¹² However, more investment is needed in nuclear power to continue to increase its share in the global electricity mix during the next three decades when global electricity demand doubles. According to the International Atomic Energy Agency's (IAEA's) projections, nuclear energy could account for 12 per cent of global electricity in 2050 in a high case scenario, up from the current 10 per cent share. In a low-case scenario, its share could drop to 6 per cent in 2050.¹³

The total number of nuclear reactors has increased from 438 in 2001 to 448 in 2020, with its net electricity generation capacity also increasing from 352.72 gigawatts to 392.61 gigawatts.¹⁴ Most of these nuclear power plants are in the developed world. The US is the largest producer of electricity from nuclear plants, followed by China and France.¹⁵ It has 93 power

¹² "World Energy Needs and Nuclear Power," *World Nuclear Association*, November 2021, <https://world-nuclear.org/information-library/current-and-future-generation/world-energy-needs-and-nuclear-power.aspx#:~:text=Nuclear%20power%20provides%20about%2010,electricity%20on%20a%20large%20scale>.

¹³ "IAEA Increases Projections for Nuclear Power Use in 2050," *IAEA*, September 16, 2021, <https://www.iaea.org/newscenter/pressreleases/iaea-increases-projections-for-nuclear-power-use-in-2050>.

¹⁴ "Nuclear Power Capacity Trend," *IAEA*, accessed May 25, 2022, <https://pris.iaea.org/pris/worldstatistics/worldtrendnuclearpowercapacity.aspx>.

¹⁵ "Nuclear Share of Electricity Generation in 2020," *IAEA*, accessed May 25, 2022, <https://pris.iaea.org/PRIS/WorldStatistics/NuclearShareofElectricityGeneration.aspx>.



Fossil versus non-fossil fuel electricity generation in 2000 and 2017 (Source: IEA World Energy Outlook)

plants,¹⁶ with only one built during the last 20 years.¹⁷

Around 53 more nuclear power plants are under construction, mostly in Asia. Only five new reactors are under construction in Western Europe and North America. These plants will add 54.52 gigawatts of electricity to the host countries.¹⁸

As many as 30 other countries are considering, planning, or building nuclear power plants. However, they all together, are not going to sufficiently add to the overall share of nuclear power globally. Of the 30 countries, presently, two have their first power plants under construction, and two more are developing the required legal and regulatory infrastructures for the construction of nuclear power plants. All others are still far away from having nuclear power plants.¹⁹

Nuclear reactors also shut down after completing their life cycle. From 2010 to 2021, 66 nuclear reactors were shut down due to various reasons. The future shutdown number and their net electricity capacity will also affect the total electricity units in the future.²⁰

¹⁶ "How many nuclear power plants are in the United States, and where are they located?," *EIA*, accessed May 25, 2022, <https://www.eia.gov/tools/faqs/faq.php?id=207&t=3#:~:text=As%20of%20December%2031%2C%202021,3%20plants%20have%20three%20reactors.>

¹⁷ Lois Parshley, "The controversial future of nuclear power in the U.S.," *National Geographic*, May 4, 2021, <https://www.nationalgeographic.com/environment/article/nuclear-plants-are-closing-in-the-us-should-we-build-more.>

¹⁸ "Under Construction Reactors" *IAEA*, accessed May 25, 2022, <https://pris.iaea.org/PRIS/WorldStatistics/UnderConstructionReactorsByRegion.aspx>.

¹⁹ "Emerging Nuclear Energy Countries," *World Nuclear Association*, updated May 2022, <https://world-nuclear.org/information-library/country-profiles/others/emerging-nuclear-energy-countries.aspx>.

²⁰ "Global number of permanent nuclear reactor shutdowns from 2005 to 2021," *Statista*, accessed May 2, 2022, <https://www.statista.com/statistics/238656/number-of-nuclear-reactors-shut-down-worldwide/>.

In contrast, the coal-fired power capacity has doubled during the past two decades to 2045 gigawatts, according to a report.²¹ While coal-fired plants with 268 gigawatts had retired in 2019, the world was set to add another 200 gigawatts of coal-fired capacity, and 300 gigawatts were also planned, mainly in China and India.²² Although the overall investment in coal-fired plants has fallen over the years, they will still contribute a major share of the world's electricity mix.

Global Efforts to Combat Climate Change

Lately, countries have been engaged in discussing the climate issue at the international level. Among the important agreements and frameworks on the climate change issue are the UN Framework Convention on Climate Change (UNFCCC), 1992, Kyoto Protocol, and the Paris Agreement.²³ The UNFCCC is ratified by 197 countries, including the United States. The landmark accord was the first treaty that explicitly addressed climate change. It established the Conference of the Parties (COP) as an annual forum for international discussions on GHGs in the atmosphere. The COP meetings led to the signing of two agreements, the Kyoto Protocol and the Paris Agreement. The Kyoto Protocol was adopted in 1997 and entered into force in 2005 and was the first legally binding climate treaty. It called upon developed countries to reduce their carbon emissions by an average of 5 per cent below the 1990s levels and established a monitoring system.²⁴

The Paris Agreement is the most important international effort made so far in this regard. Countries all over the world have committed to limiting the increase in global warming "well below" 2 degrees Celsius, intending to keep it to 1.5 degrees Celsius. They have committed to set their own targets known as the Nationally Determined Contributions (NDCs) to achieve net-zero emissions.²⁵ The agreement also aims to strengthen the ability of countries to deal with climate change impacts. The US, one of the largest emitters of carbons, did not ratify the Kyoto Protocol and withdrew from it. It had also withdrawn from the Paris Agreement on

²¹ "Global coal power," *Carbon Brief*, accessed May 15, 2022, <https://www.carbonbrief.org/mapped-worlds-coal-power-plants/>.

²² *Ibid.*

²³ Lindsay Maizland, "Global Climate Agreements: Successes and Failures," *Council on Foreign Relations*, November 17, 2021, <https://www.cfr.org/background/paris-global-climate-change-agreements.>

²⁴ "What is the Kyoto Protocol?" *United Nations Climate Change*, accessed May 15, 2022, https://unfccc.int/kyoto_protocol.

²⁵ "Paris Agreement," *United Nations Climate Change*, accessed May 15, 2022, <https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement.>

February 19, 2021.²⁶ But rejoined the agreement after President Biden took office.²⁷

However, even after that, the practical progress made under those agreements is not enough to limit the rising temperatures. Despite the growing concerns over the increasing temperatures, extreme weather patterns, climate change-induced natural calamities, and growing awareness, fossil fuels top the chart of global energy supply sources. These issues demand urgency on behalf of developed countries to increase their efforts to mitigate the effects of and reverse climate change. The steps to limit the increase in global average temperature are not sufficient to save the most threatened countries from climate effects. They are facing intense heat waves and water scarcity as additional challenges. For example, in Pakistan, the record of high temperature for March is already broken.²⁸

To counter climate change and encourage and increase the low carbon or carbon-free energy sources, including nuclear power, is mainly the responsibility of developed countries. Their share in global carbon emissions and expertise and control of nuclear power ask for their leadership on the issue. Developing countries remain among the most affected and endangered countries in the world from the climate change threat. At the same time, they lack the expertise, technologies, and resources to develop nuclear power to meet their growing national demands without the help and political support of developed countries.

Promoting Nuclear Power

The developing countries, which also happen to be climatically most threatened, need more low carbon energy due to their growing markets and economies, increasing demand for energy and electricity, and higher fossil fuels-based ratio in their electricity mixes.

Apart from increasing the allocation of more resources to tackle climate change, developed countries can come forward to help developing countries prevent and mitigate climate threats by promoting nuclear power in those countries. As discussed earlier, more than 30 countries are planning to develop nuclear power plants but face a range of challenges. Developed countries and international institutions like the IAEA can stimulate

the developing states' plans for nuclear power.

Pakistan plans to have 11 nuclear power plants with 8900-megawatt capacity by 2030 and 32 plants with 44000-megawatt capacity by 2050, thereby increasing the share of nuclear power to one-fourth of total electricity produced nationally.²⁹ In 2017, it also signed an agreement with China to build Chashma 5.³⁰ But these plans for increasing the share of nuclear power are far from becoming a reality. Currently, there is not a single nuclear power plant under construction in the country.³¹ The hindrances include political, economic, and technological issues.

The world needs to recognise the potential of nuclear energy as a low carbon source to increase the generation and use of nuclear power. Second, the advancements in nuclear reactor designs with improved safety and security are pushing for the increasing nuclear role as a safe and reliable energy source. Third, the non-proliferation regime is already strong, and the gaps can be further plugged to make it stricter and more effective. Fourth, the progress in increasing the efficiency of radioactive waste management is also encouraging news for nuclear power. Fifth, the costs of constructing a nuclear power plant can be lowered further. But, despite the higher upfront costs, the operational and production costs of nuclear power are much lower than other electricity sources. Lastly, despite all the aforementioned factors, increasing nuclear power requires political will and better planning.

²⁶ Matt McGrath, "Climate change: US formally withdraws from Paris agreement," *BBC*, November 4, 2020 <https://www.bbc.com/news/science-environment-54797743>.

²⁷ "The United States Officially Rejoins the Paris Agreement," *US Department of State*, February 19, 2021, <https://www.state.gov/the-united-states-officially-rejoins-the-paris-agreement/>.

²⁸ Aamir Yasin and Faiza Ilyas, "Karachi experiences hottest March day on record," *Dawn*, March 31, 2022, <https://www.dawn.com/news/1682647>.

²⁹ Samran Ali, "Pakistan's Nuclear Energy Program," *Strafasia*, October 24, 2020, <https://strafasia.com/pakistans-nuclear-energy-program/>.

³⁰ "Pakistan, China agree to build Chashma 5," *World Nuclear Association*, November 23, 2017, <https://www.world-nuclear-news.org/Articles/Pakistan,-China-agree-to-build-Chashma-5>.

³¹ "Plans For New Reactors Worldwide," *World Nuclear Association*, accessed May 25, 2022, <https://world-nuclear.org/information-library/current-and-future-generation/plans-for-new-reactors-worldwide.aspx>.