

Forum: COP-28

Issue: Is nuclear power a necessary part of a low-carbon energy mix, or is it too risky and should we be phasing it out?

Name: Aarshiya Agarwal

Position: Deputy Chair

Introduction:

Nuclear power forms the backbone of low-carbon electricity/energy generation. The question of whether nuclear power should be considered a necessary part of a low-carbon energy mix or phased out due to associated risks has been a subject of ongoing debate. An objective analysis of the role of nuclear power in addressing climate change and its associated risks is done by many governments and stakeholders. By examining key factors such as carbon emissions, safety measures, waste management, and the potential for alternative energy sources, this report offers insights to inform policy decisions regarding the future of nuclear power.



(Nuclear power plant)

Definition of Key Terms:

1. **Nuclear power:** Defined in the Oxford dictionary as “electric or motive power generated by a nuclear reactor.”
2. **Low-carbon energy:** Less carbon dioxide emissions are generated from certain energy sources such as nuclear power, solar power, and wind power.
3. **Renewable energy:** Defined in the Oxford dictionary as “energy from a source that is not depleted when used, such as wind or solar power.”
4. **Carbon emissions:** Defined by the National Geographic Society as “carbon compound (such as carbon dioxide) released into the atmosphere, often

through human activity such as the burning of fossil fuels such as coal or gas.”

Background Information

Nuclear Power as a solution

The demand for energy continues to rise globally, driven by population growth, economic development, and increasing standards of living. Simultaneously, the pressing challenge of climate change requires a significant reduction in greenhouse gas emissions to mitigate its effects. As a result, the need for a low-carbon energy mix has gained prominence in policy discussions. Nuclear power has been a part of the global energy landscape for several decades, providing a substantial share of low-carbon electricity generation. Currently, nuclear power plants generate approximately 10% of the world's electricity, making it a significant contributor to global carbon emission reductions. However, the use of nuclear power is a topic of debate due to concerns surrounding safety, waste management, potential accidents, and proliferation risks. High-profile incidents such as the Chernobyl and Fukushima disasters have heightened public awareness and raised questions about the viability and desirability of nuclear power.

Chernobyl

The Chernobyl nuclear disaster, which occurred on April 26, 1986, was one of the most catastrophic nuclear accidents in history. It had far-reaching consequences on various levels, affecting human health, the environment, and the perception of nuclear energy.

Some of the main issues caused by the Chernobyl disaster include:

Human Health Impact: The immediate and long-term health consequences for the people exposed to high levels of radiation were severe. The explosion and subsequent release of radioactive materials led to acute radiation sickness in workers and emergency responders, and long-term health effects such as cancers, thyroid disorders, and other radiation-related illnesses in the affected population.

Environmental Contamination: The accident released a massive amount of radioactive materials into the atmosphere, which were subsequently dispersed over a wide area, affecting large parts of Europe. Contaminated areas were subjected to radiation for an extended period, leading to soil and water contamination, affecting wildlife and agricultural practices.

Forced Evacuations and Relocations: The immediate area around the Chernobyl Nuclear Power Plant, known as the "Exclusion Zone," was evacuated and remains uninhabitable to this day due to high levels of radiation. Thousands of people were forced to leave their homes, and the accident resulted in the displacement of entire communities.

Economic Impact: The cost of dealing with the disaster, including containment efforts, cleanup, compensation, and health care for affected individuals, put significant financial strain on the Soviet Union and later, Ukraine, which inherited the responsibility for managing the site.

Global Perception of Nuclear Energy: The Chernobyl disaster had a profound impact on public perception and acceptance of nuclear energy. It raised serious concerns about the safety and risks associated with nuclear power, leading to increased scrutiny and stricter safety regulations for nuclear facilities worldwide.

Lessons Learned and Safety Improvements: The accident provided valuable lessons for the nuclear industry and regulators. It prompted significant changes in reactor design, safety protocols, and emergency response procedures to prevent similar disasters in the future.

Long-term Environmental Management: The Exclusion Zone around the Chernobyl site requires ongoing monitoring and management to mitigate environmental risks and ensure the safety of workers and visitors. The construction of the New Safe Confinement structure, completed in 2016, has helped contain the radioactive remains of the destroyed reactor and prevent further releases.

The legacy of the Chernobyl disaster continues to be felt decades later, with ongoing research on its long-term health and environmental effects. It serves as a stark reminder of the importance of rigorous safety measures and the need for continuous improvement in the management of nuclear facilities worldwide.

Nuclear reactors as fronts to hide nuclear weapon facilities

There are countries such as Iran and Russia that use nuclear reactors as fronts to hide nuclear weapons and have been under global scrutiny. Iran's nuclear program has been a topic of international concern and scrutiny. Iran possesses several nuclear reactors, including the Bushehr Nuclear Power Plant, which is the country's first operational nuclear facility. Located on the Persian Gulf coast, Bushehr is a civilian nuclear power plant constructed with assistance from Russia. Iran has

repeatedly stated that its nuclear program is intended for peaceful purposes, primarily electricity generation and medical research. However, there have been ongoing international debates and negotiations regarding Iran's compliance with the Nuclear Non-Proliferation Treaty (NPT) and concerns about its potential to develop nuclear weapons. The Joint Comprehensive Plan of Action (JCPOA) was a notable agreement aimed at limiting Iran's nuclear activities in exchange for sanctions relief, although the status of the agreement has evolved over time due to diplomatic tensions.

Current Situation

Nuclear power part of low-carbon mix

One of the key advantages of nuclear power that makes it an appealing option for many countries is its status as a low-carbon energy source. Unlike fossil fuel-based power generation, which releases significant amounts of greenhouse gases, nuclear power plants emit negligible carbon dioxide (CO₂) during their operational phase. This characteristic makes nuclear energy an essential player in global efforts to combat climate change and reduce overall carbon emissions. The process of generating electricity in nuclear power plants involves nuclear fission, where the nucleus of an atom is split to release a tremendous amount of energy. This energy is harnessed to produce electricity through a controlled chain reaction within the reactor. The primary fuel used in most commercial nuclear reactors is uranium, which is readily available in the Earth's crust. The absence of CO₂ emissions during electricity generation makes nuclear power an attractive alternative to fossil fuels such as coal, oil, and natural gas, which are the primary sources of global CO₂ emissions. Reducing carbon emissions is essential for mitigating climate change and limiting global warming to a safe threshold. The Intergovernmental Panel on Climate Change (IPCC) and other scientific bodies have emphasized the urgency of transitioning to low-carbon energy sources to achieve these climate goals. Nuclear power's low-carbon attribute makes it an essential component of many countries' climate strategies, particularly in regions where coal and other fossil fuels are prevalent. By incorporating nuclear energy into their energy mix, nations can significantly decrease their carbon footprint and meet international commitments, such as those outlined in the Paris Agreement. Furthermore, nuclear power's ability to provide continuous baseload electricity contributes to grid stability and reliability. As intermittent renewable energy sources like solar and wind depend on weather conditions, nuclear power can provide a steady and reliable electricity supply, supporting the integration of renewables and enhancing overall grid resilience. However, despite its low-carbon benefits, nuclear power is not without its challenges and controversies. Concerns about safety, waste management, high capital costs,

and public perception have influenced national energy policies and public support for nuclear energy. Governments must carefully weigh the advantages of low-carbon electricity generation against these challenges when deciding on their energy strategies. As the world seeks to transition to a sustainable and low-carbon energy future, nuclear power remains a prominent contender among the diverse mix of energy sources. Governments, policymakers, and energy stakeholders continue to evaluate the role of nuclear power in achieving climate goals while addressing its associated risks and ensuring robust safety measures. The ongoing debate surrounding nuclear energy underscores the need for a comprehensive and balanced assessment of its place in the global energy landscape.

Nuclear energy vs renewables

As the world transitions towards a low-carbon and sustainable energy future, the integration of nuclear power with renewable energy sources has become a topic of considerable interest. Both nuclear and renewable energy technologies offer important contributions to reducing carbon emissions and mitigating the impacts of climate change. Understanding how these two energy sources can complement each other is crucial for achieving a balanced and resilient low-carbon energy mix.

Here, we explore the potential synergies and challenges of integrating nuclear power with renewable energy sources:

Complementarity of Baseload and Intermittent Generation:

Nuclear Power: Nuclear energy provides stable baseload power, operating continuously and supplying a consistent amount of electricity regardless of external conditions. This characteristic ensures grid stability and reliability, supporting a steady energy supply.

Renewable Energy Sources: On the other hand, renewable energy sources like solar and wind are intermittent, generating electricity when the sun shines or the wind blows. Their output varies throughout the day and with weather conditions, making them less predictable as baseload providers.

Synergy: Integrating nuclear power with renewables allows for a complementary energy mix. Nuclear power can act as a reliable baseload provider, compensating for fluctuations in renewable energy output, ensuring grid stability, and avoiding issues related to energy intermittency.

Carbon Emission Reduction:

Nuclear Power: As a low-carbon energy source, nuclear power significantly reduces greenhouse gas emissions, making it an essential tool for decarbonizing electricity generation.

Renewable Energy Sources: Renewable energy sources, such as solar, wind, hydro, and geothermal, produce electricity without emitting CO₂ during operation, making them carbon-free and environmentally friendly.

Synergy: The combination of nuclear and renewable energy sources contributes to a substantial reduction in carbon emissions from the electricity sector. Together, they form a formidable low-carbon energy mix that can help meet climate goals and support sustainable development.

Energy Diversification and Risk Management:

Nuclear Power: Nuclear energy diversifies the energy portfolio of a nation, reducing reliance on fossil fuels and enhancing energy security.

Renewable Energy Sources: The integration of multiple renewable energy sources diversifies the energy supply further, reducing vulnerability to supply disruptions and price volatility associated with fossil fuels.

Synergy: By combining nuclear power with a mix of renewables, countries can create a more resilient and diverse energy system, better equipped to handle energy crises and unexpected events that may affect specific energy sources.

Land Use and Environmental Impact:

Nuclear Power: Nuclear power plants generally require smaller land areas compared to some renewable energy installations, making them suitable for urban environments.

Renewable Energy Sources: Large-scale renewable energy projects, such as solar and wind farms, can require substantial land areas and may have environmental impacts on ecosystems and local communities.

Synergy: Integrating nuclear power with renewables allows for efficient land use planning, optimizing the utilization of available spaces while minimizing the impact on sensitive ecosystems and reducing conflicts with land use for agriculture and other purposes. Despite the potential synergies, integrating nuclear power with renewable energy sources presents challenges. These include:

Grid Flexibility: Efficiently integrating intermittent renewable energy into the grid requires grid flexibility and energy storage solutions to balance supply and demand fluctuations. Nuclear power's constant output may reduce the need for grid flexibility but poses challenges in accommodating variable renewable energy.

Financial Viability: Both nuclear power and some renewable energy projects involve high upfront capital costs. Balancing the economic viability of nuclear power and renewable energy investments is crucial in energy planning.

Public Perception: Combining nuclear power with renewable energy may face public perception challenges. Public attitudes towards nuclear power and renewable energy technologies vary and can influence decision-making and policy support.

Safety measures and risk mitigation

Safety concerns

Safety concerns regarding nuclear power primarily revolve around the potential for nuclear accidents and the release of radioactive materials into the environment. The catastrophic accidents at Chernobyl in 1986 and Fukushima in 2011 highlighted the devastating consequences that can result from a nuclear power plant malfunction.

The primary safety concerns include:

Accidents: Nuclear accidents, though rare, have the potential for significant consequences, including radiation exposure, environmental contamination, and long-term health impacts for both workers and the public.

Radioactive Waste: The management and disposal of radioactive waste generated by nuclear power plants is a complex and long-term challenge. The safe containment and isolation of nuclear waste are essential to prevent environmental contamination and potential health hazards.

Terrorist Threats: Nuclear power plants could be targeted by terrorists seeking to cause widespread harm and disruption through sabotage or attacks, posing significant security challenges.

Human Error: Despite rigorous training and safety protocols, human errors can still occur, potentially leading to safety incidents or accidents. **Natural Disasters:** The impact of natural disasters, such as earthquakes, tsunamis, or hurricanes, on nuclear power plants raises concerns about plant safety and preparedness for extreme events.

Public Perception: Public perception and mistrust of nuclear power can influence the political and regulatory environment, affecting decisions about the construction and operation of nuclear facilities.

Advancements in reactor technology

Advancements in reactor technology have been a focal point in the nuclear industry's efforts to enhance safety, increase efficiency, reduce waste, and broaden the scope of nuclear power as a viable option for a low-carbon energy future. These advancements encompass a range of innovative reactor designs that offer various benefits over traditional nuclear reactors.

Here, we explore some of the key advancements in reactor technology:

Generation IV Reactors: Generation IV reactors represent a new class of nuclear reactors designed to meet stringent safety standards and offer superior performance compared to older reactor designs. These reactors aim to address issues such as sustainability, waste management, and non-proliferation concerns. Generation IV reactor concepts include:

a. Sodium-cooled Fast Reactors (SFRs): SFRs use liquid sodium as a coolant, allowing for higher operating temperatures and increased thermal efficiency. These reactors can "breed" their fuel, converting non-fissile isotopes into fissile material, potentially extending fuel availability and reducing waste.

b. Molten Salt Reactors (MSRs): MSRs use a liquid fluoride or chloride salt mixture as both the fuel and the coolant. They offer inherent safety features and the potential for efficient fuel utilization, reduced waste, and operating at lower pressures compared to traditional reactors.

c. High-Temperature Gas-cooled Reactors (HTGRs): HTGRs use helium as a coolant and operate at higher temperatures than conventional reactors, making them suitable for various applications, including electricity generation and hydrogen production.

Small Modular Reactors (SMRs): SMRs are a promising advancement in reactor technology, characterized by their smaller size and modular design. These reactors can be manufactured in a factory and then transported to the installation site, offering potential cost savings and flexibility in deployment. SMRs can cater to a wider range of electricity demands, including remote communities, industries, and regions with limited grid infrastructure.

Passive Safety Features: Many advanced reactor designs incorporate passive safety features that rely on natural phenomena, such as gravity and natural convection, to shut down the reactor and cool the core without the need for active control systems or operator intervention. These features enhance safety and reduce the risk of accidents.

Thorium Reactors: Thorium reactors utilize thorium as a fertile material, which can be converted into fissile uranium-233 when exposed to neutrons. Thorium is more abundant than uranium and offers potential benefits in terms of waste reduction and increased fuel efficiency. However, thorium reactor technology is still in the early stages of development.

Fusion Reactors: Fusion reactors represent an ambitious approach to nuclear power, aiming to replicate the process that powers the sun—nuclear fusion. Fusion reactors use isotopes of hydrogen as fuel and produce helium as a byproduct. Fusion offers the potential for virtually limitless and clean energy with no greenhouse gas emissions and minimal radioactive waste. However, fusion technology is still under research and development, with significant technical challenges to overcome.

High-Temperature Reactors for Process Heat: High-temperature reactors can be used not only for electricity generation but also for process heat applications in industries such as hydrogen production, desalination, and district heating. These reactors offer flexibility and potential applications beyond electricity generation.

The development and deployment of advanced reactor technology are essential for the future of nuclear power, providing solutions to the challenges faced by traditional reactor designs. However, the introduction of new technologies comes with its own set of challenges, including regulatory approval, public acceptance, and ensuring the commercial viability of these innovative designs.

Nuclear power feasibility over other low-carbon energy sources

Solar Power:

Advantages of Solar Power:

- **Abundant Resource:** Solar energy is virtually limitless and widely available, especially in regions with high solar irradiance.
- **Distributed Generation:** Solar panels can be installed on rooftops and in remote areas, enabling distributed power generation and reducing the need for extensive grid infrastructure.

- Low Operating Costs: Once installed, solar panels have minimal operating costs, resulting in low ongoing expenses.

Advantages of Nuclear Power over Solar Power:

- Baseload Power: Nuclear power provides a stable and continuous baseload electricity supply, whereas solar power is intermittent and depends on weather conditions.
- Land Use Efficiency: Nuclear power plants require less land area compared to solar farms, making them suitable for areas with limited available space.

Wind Power:

Advantages of Wind Power:

- Abundant and Renewable Resource: Wind energy is abundant, especially in coastal and open areas, and does not deplete with use.
- Rapid Deployment: Wind farms can be constructed relatively quickly, allowing for rapid capacity additions.

Advantages of Nuclear Power over Wind Power:

- Baseload Generation: Nuclear power provides steady baseload electricity, while wind power's output fluctuates with wind speed, necessitating backup power sources.
- Land Use Efficiency: Nuclear power plants require less land area compared to large-scale wind farms.

Hydropower:

Advantages of Hydropower:

- Renewable and Reliable: Hydropower relies on water flow, which is replenished by rainfall and snowmelt, providing consistent electricity generation.
- Energy Storage: Hydropower reservoirs can act as energy storage, allowing for energy balancing and peak demand management.

Advantages of Nuclear Power over Hydropower:

- Land Use and Environmental Impact: Nuclear power plants generally require less land area and have a smaller environmental footprint compared to large dams for hydropower.

Major Parties Involved and Their Views

International Atomic Energy Agency (IAEA)

The IAEA is an independent international organization associated with the United Nations. It plays a crucial role in promoting the safe and peaceful use of nuclear technology, including nuclear power, while emphasizing the importance of nuclear safety, security, and non-proliferation.

Energy companies

Energy companies that already operate nuclear power plants may view them as valuable assets for providing stable electricity and supporting low-carbon energy goals. However, the decision to invest in new nuclear projects or phase out existing ones is influenced by a combination of economic, political, social, and environmental factors, as well as the given risks of nuclear power.

United Kingdom (UK)

Nuclear electricity is a useful and low-carbon part of the UK energy mix, at the moment providing 15% of the UK's electricity. However, most existing nuclear power stations are supposed to close by 2030. The Government has a plan to increase production of nuclear energy.

France

France has one of the largest nuclear power programs in the world. Nuclear power plants in France generated 361 billion kilowatthours of electricity in 2021, accounting for 68% of the country's annual electricity generation, the highest nuclear generation share in the world.

United States of America (USA)

The United States has the most nuclear power plants in the world, it possesses a total nuclear capacity of 91.5GW, which is generated by 93 reactors that are spread across 30 of the 50 states. While the USA has more private sector participation in the production of civilian nuclear power than any other nation, the government is heavily involved through safety and environmental regulations, R&D funding, and setting national energy goals.

China

China has been steadily expanding its nuclear power fleet, to provide stable, reliable, and clean baseload electricity for its growing economy. China's latest Five Year Plan sets the 2025 target of 70GW of nuclear capacity.

Russia

Russia has 37 operating reactors and 3 under construction as of 2022, generating (GWh) 209,517 electricity.

India

Nuclear energy is the fifth-largest source of electricity for India which contributes about 3% of the total electricity generation in the country. India has over 22 nuclear reactors in 7 power plants across the country which produces 6780 MW of nuclear power.

UN Involvement, Relevant Resolutions, Treaties and Events

- Paris Agreement, 12 December 2015
Adopted in 2015, the Paris Agreement aims to limit global warming to well below 2 degrees Celsius above pre-industrial levels and pursue efforts to limit the temperature increase to 1.5 degrees Celsius. Many countries consider nuclear power as part of their strategies to reduce greenhouse gas emissions and meet their commitments under the Paris Agreement.
- Nuclear non proliferation treaty, 12 June 1968(**A/RES/2373 (XXII)**)
The NPT is an international treaty aimed at preventing the spread of nuclear weapons and promoting peaceful uses of nuclear energy. The treaty is reviewed every five years during the NPT Review Conference, where member states discuss issues related to nuclear disarmament, non-proliferation, and the peaceful use of nuclear technology.
- Resolution on Nuclear Safety (**GC(65)/RES/9**):
The IAEA regularly adopts resolutions on nuclear safety, emphasizing the importance of maintaining high safety standards in nuclear installations worldwide. These resolutions call for enhanced cooperation among member states to exchange information and experience to improve safety practices.
- Resolution on Nuclear Security (**GC(65)/RES/10**):
The IAEA addresses nuclear security in its resolutions, focusing on measures to prevent unauthorized access to nuclear materials, prevent nuclear terrorism, and enhance physical protection of nuclear facilities and materials.

- Resolution on Technical Cooperation (**GC(65)/RES/12**):
The IAEA adopts resolutions on technical cooperation to promote the use of nuclear technology for peaceful purposes. These resolutions encourage member states to participate in technical cooperation projects aimed at utilizing nuclear applications to address developmental challenges in health, agriculture, water resource management, and more.
- Resolution on Nuclear Knowledge Management (**GC(65)/RES/16**):
This resolution highlights the importance of preserving and sharing nuclear knowledge and expertise. It encourages member states to support initiatives that promote the exchange of nuclear knowledge and the development of nuclear education and training programs.
- Resolution on Climate Change and Nuclear Power (**GC(63)/RES/11**):
The IAEA acknowledges the role of nuclear power in addressing climate change by reducing greenhouse gas emissions. This resolution encourages member states to consider the potential contributions of nuclear power as part of their energy strategies to combat climate change.
- Resolution on the Implementation of the NPT Safeguards Agreement and Relevant Provisions of Security Council Resolutions in the Islamic Republic of Iran (**GC(65)/RES/23**):
The IAEA addresses specific cases related to nuclear programs and non-proliferation, as exemplified by this resolution, which relates to the IAEA's verification and monitoring activities in Iran to ensure compliance with the Nuclear Non-Proliferation Treaty (NPT) and relevant United Nations Security Council resolutions.
- Comprehensive Nuclear Testing Ban (CTBT), 10 September 1996, (**A/RES/50/245**)
The UN General Assembly adopted a resolution in 1996 calling for the early entry into force of the Comprehensive Nuclear-Test-Ban Treaty (CTBT), which aims to ban all nuclear explosions. While the treaty has not yet entered into force, the UN continues to promote its importance in preventing nuclear testing and its devastating consequences.

Possible Solutions

While forming solutions, delegates should start with root issues and address those, or divide the issue into several sub-issues. For example, with this topic clauses can be written on nuclear waste management, nuclear energy in relation to weapons, nuclear reactor design, how to use nuclear energy safely, public education etc.

It is important to choose resolution groups based on countries' stances, ie countries such as Iran, DPRK, and China, which would work together given their stance on nuclear power, and how each respective country harnesses it. Countries like the UK, the USA, and France should work together, given their stance on using nuclear energy.

- 1) **Advanced reactor designs:** Invest in research and development of advanced reactor designs that offer improved safety features, such as passive cooling systems, inherent safety mechanisms, and reduced waste generation. Newer designs like Small Modular Reactors (SMRs) and Generation IV reactors show promise in addressing safety concerns and increasing feasibility.
- 2) **Robust regulatory oversight:** Enhance regulatory frameworks and safety standards to ensure that nuclear power plants adhere to the highest safety protocols. Regular inspections and stringent safety measures are essential to minimize the risks associated with nuclear facilities. **Improved waste management:** Develop better strategies for nuclear waste disposal and recycling. Advancements in waste storage, transportation, and reprocessing technologies can help minimize the environmental impact and long-term risks associated with nuclear waste.
- 3) **Public education and engagement:** Address public concerns through comprehensive education about nuclear power, its safety measures, and potential benefits. Engage with communities living near nuclear facilities to foster transparency and trust. **Risk communication:** Implement effective communication strategies to convey risks associated with nuclear power accurately. This helps to manage public perception and ensures that people have realistic expectations about nuclear energy's benefits and challenges.
- 4) **Diversification of energy sources:** Although nuclear power can be a valuable part of a low-carbon energy mix, it should not be the sole solution. A diversified mix, including renewables like solar, wind, hydro, and geothermal, along with energy storage solutions, can enhance energy security and reduce reliance on any single source.
- 5) **Long-term decommissioning planning:** Include provisions for the eventual decommissioning of nuclear power plants in their initial design and budgeting. Proper decommissioning ensures safe closure and remediation of nuclear facilities once they reach the end of their operational life.
- 6) **International collaboration:** Foster international cooperation on nuclear safety standards, research, and emergency response planning. By sharing knowledge and best practices, countries can collectively address safety concerns and improve the overall feasibility of nuclear power.

- 7) Financial incentives and support: Offer financial incentives, subsidies, or tax breaks to encourage the development of nuclear power projects and accelerate research into safer and more efficient technologies.
- 8) Incorporate lessons from past incidents: Learn from historical nuclear accidents, such as Chernobyl and Fukushima, to identify vulnerabilities and avoid similar mistakes in future projects.

Bibliography

Useful Links

[Paris agreement](#)

[Nuclear power country by country](#)

[Nuclear reactor as fronts to hide nuclear weapon facilities](#)

[Chernobyl disaster](#)

Works Cited

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- [IEA \(Nuclear power in a clean energy system\)](#)
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