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The diverging nuclear histories and futures of Kazakhstan and Uzbekistan

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Highlights:

- Despite shared Soviet legacies, Kazakhstan and Uzbekistan pursue nuclear energy differently: Kazakhstan revisits a traumatic nuclear past amid public skepticism, while Uzbekistan engages in a top-down, Russian-dependent development strategy.
- Both countries are leveraging nuclear energy to meet renewable targets and energy demand within the context of their individual geopolitical ties with Russia, China, and the West.
- Kazakhstan's anti-nuclear history forms current debates amongst the citizenry, contrasting with Uzbekistan's technocratic approach and absence of direct nuclear trauma.

Abstract: Kazakhstan and Uzbekistan are two post-Soviet countries, rich in resources and with interwoven histories, starting their journey toward nuclear energy. To meet new energy targets, the two countries are approaching the building of nuclear power plants, increasingly considered a significant shift in energy strategy. However, though Kazakhstan and Uzbekistan share Soviet histories, they have two different starting points to develop nuclear industries. Kazakhstan experienced nuclear tests at the Semipalatinsk Test Site, which created doubts about nuclear energy, which are being discussed today in light of the possibility of building a nuclear power plant in the country. To this end, a referendum was held in October 2024 to investigate the population's views on the start of a nuclear project. Uzbekistan does not have the same nuclear experience as Kazakhstan, being a provider of uranium during Soviet times, but not directly involved in the nuclear tests. The country aligned with the Russian proposal to support the building of a nuclear power plant while also reinforcing its uranium mines, as the country does not have other experience with renewables. This paper proposes a comparison between Kazakhstan and Uzbekistan's approach, showing the ways they conceive nuclear energy, how they are working towards the plants' construction, and the process of counterbalancing geopolitical forces around the nuclear theme. Kazakhstan and Uzbekistan were selected as case studies to show how two countries with a common Soviet past, but yet different experiences with nuclear energy, are now choosing to compel to a shared goal in the future, highlighting unique and different conditions for the development of nuclear policy in post-Soviet states. The comparison aims at showing that even though the two countries share a common Soviet past, they are developing independently, as seen by commonalities and differences in

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their approaches towards building new nuclear facilities. At the same time, two approaches have been highlighted: the choice of strategic partnership with Russia by Uzbekistan, and the attention to public perception of Kazakhstan. This contribution's goal is to provide a qualitative perspective around the choice of nuclear energy in divergent Soviet-era experiences and the shaping of contemporary nuclear policies.

Keywords: nuclear energy; nuclear policy; Kazakhstan; Uzbekistan

1. Introduction

Kazakhstan and Uzbekistan, two resource-rich countries with intertwined Soviet histories, are navigating complex paths toward energy diversification and sustainability, having set significant renewable energy targets to meet growing energy demands and contribute to climate change mitigation. The two states have turned toward nuclear energy to support this diversification, but their approaches and motivations for nuclear development differ as they balance geopolitical pressures and socioecological considerations. While Kazakhstan has several established solar and wind projects, Uzbekistan is still in the embryonic phase of its renewable energy development. At the same time, nuclear energy is increasingly discussed as the solution to the region's growing energy needs, as the "next frontier." Kazakhstan's complicated nuclear past, exemplified by the heavily used Semipalatinsk Test Site during the Soviet period, resurfaces in the form of a new debate over a planned nuclear power plant (NPP), renewing historical fears and introducing modern resistance. In contrast, Uzbekistan only recently developed a policy framework for renewables and does not have a history in nuclear development during the Soviet era. In 2019, Uzbekistan started planning to build an NPP with the help of the Russian Federation to be located in the Farish region, though its failure to materialize as of today (June 2025) raises questions about its realization. This paper explores how Kazakhstan and Uzbekistan's paths toward nuclear energy production diverge, from the Soviet era to the present day, examining how their historical legacies, domestic current affairs, and geopolitical alliances are influencing their approaches to nuclear energy. Despite similar Soviet legacies, Kazakhstan and Uzbekistan have diverged in nuclear energy policy due to historical trauma, public sentiment, and geopolitical positioning and strategy, putting them on markedly different atomic trajectories.

2. Historical context

In order to understand the strategic choices Kazakhstan and Uzbekistan are making regarding nuclear energy development today, it is important to understand how nuclear power was manifested prior to their independence. For four decades, the eastern region of the Kazakh Soviet Socialist Republic was the testing ground for Soviet nuclear experiments and bomb development. Semipalatinsk, known as the "Polygon," was the site of over 450 nuclear tests [1]. Throughout the project, the local population was not informed about the testing or its potential dangers [1,2]. This way of operating without public knowledge, consent, or participation in decision-making processes is echoed in the way Kazakhstan's largely state-led extractive and resource development projects function today. However, as the testing went on and the power of the bombs grew, the ramifications for local people and the surrounding environment became harder to ignore and to hide, leading eventually to the formation of an anti-nuclear movement. The Nevada Semipalatinsk movement gained momentum and global attention, culminating

in a 50,000-person demonstration in front of the Polygon on the 44th anniversary of Hiroshima. These protests successfully pressured Soviet authorities, and the Semipalatinsk Nuclear Test Site was closed in 1989, after the explosion of a cumulative "1.77 megatons, the equivalent of a thousand Hiroshima bombs" [1]. The anti-nuclear grassroots campaign marked one of the first significant public opposition movements in the Soviet Union [3], helping shape Kazakhstan's national identity and acting as a unifier amongst its citizenry against Soviet policies as the regime began to collapse.

Since the beginning of its implementation in Soviet times, the relationship between Uzbekistan and nuclear energy production has differed greatly from that of Kazakhstan. Similarly to the other countries in Central Asia, Uzbekistan is rich in uranium, having the world's seventh-largest reserves according to IAEA [4]. Uzbekistan's largest deposit is located in the Kyzyllum desert. This raw material, crucial for atomic and nuclear research and experiments, is processed on-site, primarily in the Navoi Mining and Chemical Combine [4]. During Soviet rule, these sites not only extracted and worked with uranium but also exported it to facilitate research in other research centers around the USSR. Following the collapse of the Soviet Union, many of those extractive sites were abandoned, bringing Uzbekistan to the unforeseen issue of radioactive waste management: as of today, around 57 million tons of solid waste are still to be processed [4]. However, the dumps created during the USSR, inherited by the Central Asian countries, do not satisfy current security protocols and in some cases, they risk harming the population nearby [4]. Generally, hazards to the population are one of the main obstacles to local acceptance of nuclear energy and research.

Unlike Kazakhstan, Uzbekistan has never possessed a site for nuclear weapons testing. The absence of such infrastructures continues to influence the evolution of nuclear energy in the country to this day. The only reminiscence of nuclear reactors is the VVR-SM nuclear research reactor. The VVR-SM is currently active at 10MW in Tashkent, but the scope of its activity is different from the Semipalatinsk facility, as it is operative only for research and educational purposes [5]. However, the reactor has been converted to a low-proliferation risk by operating with low-enriched uranium [6].

After the demise of the USSR, the former Soviet Republics had to re-adjust their energetic supplies and act independently as sovereign states. On August 29th, 1991, Nursultan Nazarbayev, then Chairman of the Kazakh Soviet Socialist Republic Council of Ministers and later Kazakhstan's first president, formally closed the Semipalatinsk Test Site, a day now commemorated as International Day Against Nuclear Tests [7]. After declaring its independence on December 16th, 1991, Kazakhstan inherited the Soviet's nuclear arsenal, then the world's fourth largest, of over 1,200 nuclear warheads and significant missile delivery systems [8]. As part of its efforts to forge new relationships with the United States and Europe, Kazakhstan embarked on a journey toward denuclearization, firstly by signing the Lisbon Protocol in 1992, along with Belarus, and Ukraine. By becoming a party to the Protocol, Kazakhstan committed to complying with the Nuclear Non-Proliferation Treaty (NPT), which it then ratified in 1993.

While the NPT bans nuclear weapons, it permits the use of nuclear technology for what it deems as 'peaceful' purposes [9]—a provision that raises ethical and environmental questions about the extent to which the extraction of uranium, construction of nuclear power plants, and indefinite storage of nuclear waste damage the environment can be viewed as nonviolent processes [10].

As Kazakhstan continued dismantling its nuclear weaponry, including the transfer of nuclear warheads back to Russia by 1995, and the decommissioning of the BN-350 fast breeder reactor in Aktau used for power generation and desalination in 2000, it began exploring new, 'peaceful' nuclear

operations, via the new national atomic company, Kazatomprom, founded in 1997 to oversee uranium mining and nuclear fuel and energy production. Throughout the early 2000s, Kazakhstan maintained its anti-nuclear weapon status, becoming a founding member of the Central Asian Nuclear-Weapon-Free Zone, a treaty prohibiting nuclear weapons in the region, while continuing its promotion of nuclear energy development. In 2009, Kazakhstan proposed hosting the International Atomic Energy Agency (IAEA) low-enriched uranium (LEU) bank to enhance global nuclear fuel security and mitigate proliferation risks. During the 2010s, Kazakhstan emerged as a leader in nuclear diplomacy, launching the Green Bridge Partnership Program in 2012 to promote sustainable development, with nuclear energy as a key component. By 2015, it formalized an agreement to host the IAEA LEU Bank at the Ulba Metallurgical Plant, which became operational in 2019, and it hosted the 2017 Astana Expo, featuring nuclear power's role in sustainable development and demonstrating Kazakhstan's use of energy as a diplomatic tool [11]. In 2024, supported by government policies and driven by foreign investment, Kazakhstan's renewable energy generation totaled 6.43% [12], though barriers to systematizing renewable energy remain, such as infrastructural segmentation [13]. More recently, there has again been renewed government interest in domestic nuclear energy. Feasibility studies for a new nuclear power plant were conducted in 2022, as Kazakhstan reaffirmed its position as the world's largest uranium producer in 2023, supplying over 40% of global demand.

As with Kazakhstan, newly independent Uzbekistan had to reorient its energy strategy, making decisions that would inform and reflect its political and economic aspirations. It is claimed that Uzbekistan reached energetic independence in 1995 because of the decisions made by the Uzbek leadership [14], including the withdrawal from the United Energy Grid of Central Asia (UEGCA) in 2009, which separated Uzbekistan from the other countries in the region [4]. For this reason, recent developments in energetic infrastructures had to do with efficiency, security, and reducing its impact on the environment [14]. Uzbekistan's energy sector highly relies on natural gas accounting for 70% of total energy consumption in the last 30 years [15]. Renewables occupy a secondary role: the main source is hydropower, with 42 production centers, and an output of 1.68 GW [16]. Electricity production increased significantly from 2010 to 2022, topping 75.1 kWh, and prompting import from neighboring countries to meet rising demand [16]. By 2030, the goal of Uzbekistan is to produce 25% of its energy through renewables, particularly 4.300 MW with solar and wind power and 2,4 GW with nuclear energy [15]. More recently, the country has pledged to increase its energy generation to 117 billion kWh by 2030, and to do so Uzbekistan does not only need to improve already-existing facilities but also start considering new technologies and strategies [14]. To this end, Uzbekistan has faced the possibility of building a nuclear power plant (NPP) in its territory, already in 2019 [14]. After the sudden death of President Islam Karimov and the subsequent election of Shavkat Mirziyoyev, the building of an NPP was fast-tracked into the Uzbek agenda, leading to a series of bilateral agreements and a number of domestic laws to implement the facility as soon as possible. It is argued that the proposal of Vladimir Putin to build a Russian-made NPP in Kazakhstan was an attempt to replicate a success he quickly achieved through Mirziyoyev's ascent to power [17]. This consequentiality in events, among other factors, caused the NPP construction to be much discussed in Kazakhstan, leading to a referendum and creating an unimaginable public debate for the Uzbek case.

3. Current developments

In October 2024, Kazakhstan held a state-wide public referendum posing just one question: "Do you agree with the construction of a nuclear power plant in Kazakhstan?" [18]. This vote revisited a decades-long debate, with discussions over whether to have a nuclear power plant in Kazakhstan dating back to 1998 [19]. Previous efforts to establish an NPP failed largely due to public opposition, amongst other bureaucratic challenges, but this time the official results claim about 70% of voters are in favor, though there were several reports of ballot stuffing and detention of activists ahead of the election, casting doubt on the authenticity of these results and the true sentiments of the public. Recent studies have also demonstrated high percentages of anti-nuclear sentiment, specifically in the eastern region near Semipalatinsk [20]. The current location favored for the NPP is on the shores of Lake Balkhash, with discussion over whether Russia's Rosatom, China's CNNC, South Korea's KHNP, or France's EDF could serve as Kazatomprom's partner, though President Kassym-Jomart Tokayev has publicly discussed the possibility of a multi-corporation project [18].

Kazakhstan's energy trajectory closely charts its efforts to maintain a geopolitically advantageous place on the international stage, often balancing its relationships with Russia and China against countries in the west. There is a considerable amount of skepticism regarding the possible partnership with Rosatom, due to the dark histories of Semipalatinsk and Chornobyl under Soviet leadership and the recent occupation of Ukraine's Zaporizhzhya nuclear power plant as a part of Russia's full-scale invasion [21]. Opponents fear the NPP partnership with Russia would compromise Kazakhstan's independence and governance, making it vulnerable to external interference. Uzbekistan's necessity for energy diversification from the predominant use of natural gas [22] and the richness of uranium, still operated by the Navoi Mining and Metallurgy Plant, and the perspective of new investment in that sector [4,23], lead the country to consider the use of nuclear energy. To this end, Uzbekistan turned towards a long-lasting partner: the Russian Federation.

The collaboration with Russia in the nuclear sector started as early as 2017, with the sudden election of Mirziyoyev as President of Uzbekistan and the signature of a bilateral agreement for cooperation to the use of atomic energy for peaceful goals [24] and the following year a bilateral agreement was signed for the construction of an NPP on the Uzbek territory [25]. To reach the goal, the country started adapting its legal framework for nuclear energy development and getting ready to receive assistance from Russian staff and its know-how [26]. It can be argued that the pandemic, together with other priorities, may have slowed down the process. However, in October 2024, the Uzbek legislation culminated with a measure dedicated to NPP, emphasizing the international cooperation needed in the process [27]. In May 2024, Russia and Uzbekistan signed the latest bilateral agreement officially building an NPP in the Jizzax region composed of two reactors VVER-1200 with a capacity of 1.200 MW each [22].

The implementation of nuclear energy by Central Asian countries supported by Russia mirrors a trend that has also affected other developing countries, such as Turkey, India, Egypt and Slovakia [28]. It is safe to say however, that Central Asian countries have a smoother and less troubled route toward the construction of new facilities thanks to their Soviet heritage, which enables Russian companies, such as Rosatom to operate unobstructed [28]. Moreover, since the invasion of Ukraine in 2022, Uzbekistan has become one of the countries through which Russia diverts its entry point for sanctioned goods, making it a strategic ally [29,30]. The new NPP has been defined "vital" by Mirziyoyev, cementing the

support to Russia and its influence in the region [29]. Even in this seemingly serene energetic transition, complaints and critiques to the project have been manifested, particularly regarding the seismicity of the region, and the consequent danger it may cause for the population [31].

The Russian Federation is not the only investor turning towards Central Asia because of its richness in uranium. China as well has demonstrated interest in the excavation of two mines cooperating with its state-run company China Nuclear Uranium [32]. The same can be said for Europe as Orano, a French-state company, has manifested interest in a collaboration. Therefore, it can be said that many geopolitical powers are turning towards Central Asia. The following section outlines how these foreign interests, along with pre-independence resource management—Kazakhstan's nuclear testing legacy and Uzbekistan's role as a uranium-supplier—shape each country's energy diplomacy and geopolitical positioning.

4. Geopolitical dynamics shaping the future

As Kazakhstan and Uzbekistan consider their atomic energy futures, they must navigate differing sets of geopolitical situations—both with countries like Russia and China, as well as between themselves. Uzbekistan's tentative plans to build an NPP near the Kazakh border have provoked significant opposition amongst Kazakh locals. According to a survey conducted by the Eco-Museum in Karaganda, Kazakhstan, 89.5% of respondents were against the proposal, though participants generally viewed nuclear energy development more favorably. This illustrates a classic case of 'not in my backyard' politics, where support for nuclear energy may be conditional upon its distance from one's own community. Moving forward, policy and resource governance must prioritize environmental justice, within and around each country's borders.

On an international scale, Russia's efforts to support nuclear industries in Central Asia can be viewed as economically and geopolitically strategic. There are concerns amongst the local population that the power plants could be used as tools for political or economic control, though Presidents Tokayev and Mirziyoyev have publicly embraced partnerships with Russia, emphasizing the favorable positioning of their countries within such collaborations. Kazakhstan has a more powerful position on the global stage than Uzbekistan, and thus independence in resource strategy. While Kazakhstan has sought other strategic relationships with China and the west, as reflected in their multi-corporation proposal for the planned NPP, and particularly since the beginning of Russia's war in Ukraine [33,34], it still relies heavily on Russia for infrastructure and exports of raw materials. As such, it upholds a friendly relationship with Russia, maintaining their joint project, the Caspian Pipeline Consortium through which 80% of Kazakhstan's exports pass [34] Uzbekistan in particular is increasingly adopting a pragmatic approach, by turning toward various actors who are willing to invest in the country and help it reach the goal. At the same time, because of the lack of sufficient resources and infrastructures, the interlink with the Russian Federation is vital, as well as the partnership with other international actors, though they seem to struggle to diversify their partnerships beyond Russia.

Kazakhstan and Uzbekistan have also made international commitments to sustainable development and emission reductions under their Nationally Determined Contributions as part of the Paris Agreement. These obligations place them under a certain amount of scrutiny by western countries, and they must maintain good relationships outside of their immediate neighborhood, essential for securing foreign investment and achieving their sustainable development targets. Balancing domestic energy needs with

these international commitments and geopolitical alliances will be critical as they shape their nuclear energy policies and trajectories.

5. Conclusion

While Kazakhstan and Uzbekistan share Soviet legacies, uranium wealth, and ambitions for energy diversification, their nuclear trajectories reveal divergences rooted in history, public sentiment, and geopolitical positioning, bringing the two countries to explore nuclear development with dissimilar courses of action and approaches. Kazakhstan cautiously explores nuclear energy as an option, but both its population and its political leadership are haunted by the trauma of Semipalatinsk, leading to a contested return to nuclear energy, now branded as 'peaceful' and tied to international diplomacy. On the contrary, Uzbekistan, participating in the Soviet nuclear process only with its natural resource deposits, pursues nuclear development as a largely technocratic solution to energy insecurity, with fewer public debates but continuing dependence on Russia. These diverging paths illustrate how nuclear energy in Central Asia is deeply embedded in the countries' socio-political memory. As Kazakhstan experience shows, historical trauma can lead to continued resistance for development, as well as a desire for state ownership over nuclear narratives, while Uzbekistan's trajectory highlights how this absence enables it to align more closely with external forces to accelerate its nuclear ambitions. Future research could benefit from a thorough comparative policy analysis or narrative analysis of media and government statements to more precisely pinpoint areas of departure of these two state strategies and forecast how they may develop. Amid global pressures to diversify and decarbonize the energy sector, the role of nuclear energy will continue to be shaped by how each country navigates its past and present. Ultimately, the "atomic futures" of Kazakhstan and Uzbekistan will remain contingent on how they develop their nuclear policies alongside differing priorities on sovereignty, safety, and public buy-in.

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Authors' contribution

Mariel Kieval: conceptualization, writing—original draft preparation, reviewing, and editing. Greta Miravalle: conceptualization, writing—original draft preparation, reviewing, and editing.

Conflicts of interests

The authors declare no conflict of interest.

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