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Civil Nuclear Energy Cooperation between China and Central Asia amid the Energy Transition: Drivers, Institutional Constraints, and Policy Pathways

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Abstract

This article examines how energy transition goals, industrial complementarity, partner diversification, and institutional capacity shape civil nuclear energy cooperation between China and Central Asian countries. It develops a three-level framework covering national demand, international political economy, and institutional conditions, and proposes a nested comparison of Kazakhstan and Uzbekistan. Publicly documented cooperation in nuclear fuel manufacturing and nuclear safety regulation illustrates distinct channels of engagement. The available evidence supports a research design and preliminary case descriptions; it does not yet establish the proposed causal mechanisms or the outcomes of planned nuclear power projects. The article specifies observable indicators, process-tracing tests, and policy implications for cooperation under international safety standards.

Keywords

Civil nuclear energy; China; Central Asia; Kazakhstan; Uzbekistan; energy transition; institutionalization.

1. Introduction

Global climate governance, energy security and industrial restructuring are intertwined, driving countries to re-examine the stability, affordability and low-carbon goals of the energy system. The rapid development of renewable energy provides new momentum for energy transformation, but the volatility of its output, as well as conditions such as grid flexibility, energy storage scale, and infrastructure investment, still require countries to comprehensively configure different types of power sources. Against this background, civilian nuclear energy, as a technology option that has low direct carbon emissions during operation and can provide relatively stable power, has once again become an important issue in the energy strategies of some countries. However, issues such as nuclear power construction cycles, capital investment, nuclear safety, radioactive waste management and public acceptance mean that nuclear energy does not have the same economics and policy suitability in all countries and scenarios. To study nuclear energy development policies, it is necessary to put energy security, development stages, governance capabilities and national independent choices in the same analytical framework.

Unlike traditional oil and gas trade, civil nuclear energy cooperation often covers uranium resource exploration and mining, conversion and enrichment, nuclear fuel manufacturing, nuclear power plant construction, operation and maintenance, waste management, nuclear safety supervision and long-term talent training. There are obvious differences in the technical thresholds, investment methods, license systems and international rule constraints of each link. Therefore, international cooperation in nuclear energy cannot simply be summarized by bilateral trade volume or the number of projects. Its formation and stable operation involve multiple interactions between national strategies, corporate commercial interests, regulatory

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systems, and international institutions. The milestone method for the development of nuclear power infrastructure proposed by the International Atomic Energy Agency covers 19 infrastructure issues such as national positions, legal systems, nuclear safety, supervision, human resources and waste management, indicating that countries newly entering the nuclear power field face not only power plant construction issues, but also system-wide public governance construction issues [3].

Central Asia is rich in energy resource endowments, but the energy structure and development priorities of the five countries are not consistent. Kazakhstan has an important uranium resource and nuclear fuel industry foundation, and its policy agenda includes both the extension of the resource product value chain and domestic nuclear power construction; Uzbekistan has uranium resources and growing power demand, and is promoting nuclear power construction and improving the nuclear energy regulatory system; Kyrgyzstan, Tajikistan, and Turkmenistan have different characteristics in their energy structure, infrastructure conditions, and policy agenda. Considering Central Asia as a whole as a single nuclear energy market, it is easy to ignore the differences between countries in economic development, institutional capabilities, technological foundations and foreign cooperation strategies.

Take Kazakhstan as an example. Information updated by the World Nuclear Association in October 2026 shows that the country has long been an important uranium producer in the world. In 2025, its uranium production was approximately 25,839 tons of uranium, accounting for approximately 40% of the global total. Its nuclear fuel assembly manufacturing capabilities have been substantially expanded, but commercial nuclear power construction projects still must distinguish different stages such as planning, contracting, and construction [4]. In Uzbekistan, the country information updated by the World Nuclear Association in October 2026 shows that nuclear power project planning includes reactors of different capacity levels and is linked to power demand, gas dependence and industrial upgrading issues in domestic policies [5]. These experiences provide a realistic basis for comparing nuclear energy development policies, industrial foundations and international cooperation paths in different countries.

China and Central Asian countries have accumulated cooperation in the energy field for a long time, and traditional research mostly focuses on oil and gas resource development, pipeline transportation and energy security. With the development of China's nuclear power industry system and the adjustment of nuclear energy policies in Central Asian countries, new forms of cooperation between the two parties in the nuclear fuel industry chain, nuclear energy technology and nuclear safety governance have emerged that are worthy of attention. In June 2025, the "Astana Declaration of the Second China-Central Asia Summit" clearly proposed to establish a China-Central Asia energy development partnership, expand cooperation in the entire energy industry chain, and deepen cooperation in the peaceful use of nuclear energy [1]. This has given civilian nuclear energy cooperation a new multilateral policy background, but the cooperation direction expressed in the summit documents and the implementation results of specific commercial projects still need to be distinguished.

China-Kazakhstan nuclear fuel cooperation has observable evidence of continuous projects. Information from the Kazakhstan State Atomic Energy Industry Company shows that the Ulba-FA nuclear fuel assembly factory jointly built by the two parties will be put into production in 2021 and will reach the design production capacity of 200 tons of low-enriched uranium equivalent fuel assemblies per year in 2024. The products will be supplied to the Chinese nuclear power market [6]. This project involves equity arrangements, technology certification, long-term procurement and cross-border industrial chain collaboration, providing a good case for analyzing the institutionalization of cooperation. In contrast, China-Uzbekistan nuclear energy cooperation has made new progress in terms of supervision and capacity building. The Uzbek government announced in January 2026 that the Uzbek authorities and the China

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National Nuclear Safety Administration signed a memorandum of understanding on nuclear and radiation safety regulatory cooperation. The cooperation matters involve regulatory infrastructure, legal systems, and human resource training [7]. This is a formal arrangement for institutional cooperation, but its subsequent implementation results need to be tracked and verified.

At the same time, there are Russian and other international players in the field of nuclear power construction in Central Asia. Kazakhstan's proposed nuclear power project and Uzbekistan's nuclear power construction plan show that the country may choose different partners in different industrial links [4][5]. The core question arising from this is not "whether China participates in cooperation", but "under what conditions, in what way China participates, and how can cooperation be institutionalized?" This issue has both international political economics explanatory value and China's energy foreign policy significance.

This article asks which domestic and international factors shape the formation, form, and institutionalization of civil nuclear energy cooperation between China and Kazakhstan and Uzbekistan. It distinguishes implemented industrial projects from agreements, regulatory cooperation, and proposed power plants. The contribution is an integrated framework and an evidence-based comparative research design, with claims calibrated to the stage of each project.

2. Literature Review and Theoretical Framework

2.1. Energy security and transition

Energy security research has gradually expanded from traditional resource availability to dimensions such as price affordability, technical system reliability, sustainability and governance capabilities. Sovacool and Mukherjee proposed to comprehensively measure energy security from five dimensions: resource availability, price, technology development, sustainability and supervision [9]. This framework enlightens researchers that nuclear power policies cannot be evaluated solely based on "whether to reduce dependence on fossil energy", but also need to examine conditions such as capital costs, technology supply, nuclear fuel security, and regulatory capabilities.

Energy transition research emphasizes the co-evolution of energy structure changes and policy systems. The country's adjustment of the energy system is not purely determined by technology costs. Industrial foundation, social acceptance, public finance and policy implementation capabilities will also affect path selection. As far as Central Asia is concerned, research should prevent the direct transplantation of nuclear power development experience in other regions to the local area, but need to examine the country's development stage, power system structure and specific energy security issues. The existing energy transition literature provides a comprehensive perspective for analyzing nuclear power policies, but comparative research on nuclear energy choices in Central Asian countries still needs to be deepened.

2.2. Interdependence and political economy

Keohane and Nye's theory of complex interdependence emphasizes that relations between countries are not only composed of military and security issues, but also that various social and economic ties will change national interests and policy choices [8]. For the nuclear energy industry chain, feedstock supply, fuel manufacturing, technology licensing, long-term procurement and regulatory arrangements can create different forms of interdependence. A further distinction needs to be made between "sensitivity" and "vulnerability" to interdependence: the former focuses on the immediate impact of external changes, the latter focuses on the costs of finding alternatives.

However, complex interdependence does not automatically explain partner selection for all nuclear power construction projects. Major nuclear power projects are often also affected by

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national strategies, financing conditions, technological maturity and long-term diplomatic relations. Therefore, research should adopt an open competitive explanatory framework, compare industrial complementarity, commercial terms and international political factors, and avoid directly attributing a certain cooperation result to a single major power relationship.

2.3. Energy governance and nuclear institutions

"Global Energy Governance: New Rules of the Game" edited by Goldthau and Witte emphasizes the role of institutional arrangements in energy market stability, risk sharing and governance coordination [10]. The international system in the nuclear energy field is more specialized, including the International Atomic Energy Agency's nuclear safeguards and safety standards, national nuclear safety laws and regulations, and project-related procurement, financing and liability arrangements. International institutions may reduce cooperation uncertainty and may also create barriers to entry due to differences in licensing costs or standards.

The International Atomic Energy Agency's Nuclear Power Infrastructure Milestone Framework provides operational tools that can be used to compare institutional capabilities, including 19 areas such as regulatory framework, nuclear safety, nuclear security, safeguards, financing, nuclear fuel cycle and human resources [3]. This framework can help explain why countries with the same willingness to develop nuclear energy differ in terms of cooperation content, negotiation speed and implementation stage. But its essence is a normative guiding framework, and research cannot treat it as a causal explanation for a given project's success without testing it.

2.4. Research gap and analytical framework

In general, the energy security and transition literature provides tools for analyzing national needs, complex interdependence theory provides an explanatory path for transnational industrial linkages, and global energy governance research emphasizes the importance of institutions and rules. However, there is still room for expansion in regional research that integrates national energy transition needs, international partner selection, and nuclear energy institutional governance into the same testable framework.

This study intends to make up for three specific shortcomings: first, it uses each link of the nuclear energy industry chain as the unit of analysis to avoid treating "nuclear energy cooperation" as a single act; second, it compares the different cooperation models of two countries in similar regional backgrounds, and tests the respective roles of domestic demand, international structure, and institutional conditions; third, it distinguishes cooperation intentions, agreement signing, project implementation, and actual results through project timelines and verifiable data. This advances descriptive research to mechanistic research.

The first level is the national demand level. Electricity supply and demand, energy structure, industrial development goals and emission reduction policies are regarded as basic conditions affecting the demand for civil nuclear energy cooperation. National policy is not a simple function of “demand” but is translated into specific goals through domestic decision-making processes, budgets and industrial policies.

The second level is the international political and economic structural level. Incorporate resource and technology complementarity, partner selection, diplomatic relations, and financing conditions into the analysis. Different countries can form a division of labor in nuclear fuel, nuclear power projects, regulatory cooperation and other aspects; different partners may also form competitive relationships in some aspects. The focus of the research is to distinguish the relative roles of political, economic and technological factors at specific decision-making nodes.

The third level is the institutional condition level. Examine the institutional arrangements such as nuclear safety supervision and technical standards, approval and licensing, long-term

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contracts, equity structure, dispute settlement and talent training. Institutions may serve as pre-constraints for cooperation, or they may be gradually formed during the cooperation process. The study will distinguish preconditions from collaboration outcomes through chronological order.

The three levels affect the results through the chain of "cooperation demand identification - partner and project negotiation - institutional coordination - project execution and feedback". The core explained variables are the choice of cooperation model and the degree of institutionalization, which assist in examining the sustainability of cooperation, capacity building and actual contribution to energy policy goals.

3. Research Questions and Propositions

3.1. Scope and research questions

This study defines "civilian nuclear energy cooperation" a cross-border cooperation carried out by governments, regulatory agencies and enterprises around the nuclear fuel industry chain, nuclear power technology and construction, nuclear safety governance and talent training under the premise of peaceful use of nuclear energy. It does not involve military nuclear activities. "Energy transition" refers to the process by which the country adjusts its energy structure, infrastructure and governance arrangements to achieve energy security, development and emission reduction goals. "The degree of institutionalization of cooperation" refers to the degree to which cooperation has transformed from an expression of intention to one with clear rules, responsible entities, ongoing implementation arrangements and verifiable performance records.

The research mainly focuses on the relevant cooperation between China and Kazakhstan and Uzbekistan from 2013 to 2026, and dynamically tracks subsequent policy changes during the doctoral stage. Kyrgyzstan, Tajikistan and Turkmenistan are mainly included as regional backgrounds with limited supplementary comparisons and are not forcibly included in the analysis of homogeneous nuclear power projects.

The overall question of this study is: In the context of global energy transition and the adjustment of the Eurasian energy pattern, what domestic and international factors are jointly affected by the formation, cooperation model selection and institutionalization process of civil nuclear energy cooperation between China and Central Asian countries?

Around the general question, four sub-questions are set: First, how do the energy security, low-carbon transformation and industrial development goals of Central Asian countries create demands for nuclear energy cooperation? Second, how do resource and technology complementarity, commercial financing conditions, and international partner diversification considerations affect the selection of partners and cooperation links? Third, how do nuclear safety supervision, standard certification and contract systems affect cooperation from agreement to continuous implementation? Fourth, how should China improve the institutional arrangements for cooperation and risk management on the basis of respecting local development needs and international nuclear safety rules?

3.2. Testable propositions

H1 (National Demand Hypothesis): When other conditions are basically similar, the clearer the energy security and low-carbon transformation goals of Central Asian countries, the stronger their policy will to promote international cooperation in civil nuclear energy. This hypothesis is tested through energy planning, policy introduction and project agenda changes, and does not directly equate policy willingness with project success.

H2 (Industrial Complementarity Hypothesis): The stronger the complementarity between China and Central Asian countries in terms of resources, nuclear fuel manufacturing, technology

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and market, the more likely both parties are to form long-term procurement, joint investment or stable supply arrangements in the corresponding industrial links.

H3 (Partner Diversification Hypothesis): When Central Asian countries regard diversification of external cooperation as an energy security goal, they are more likely to introduce different partners in different links of the nuclear energy industry chain. This assumption focuses on policy evidence and specific partner selection, and does not presuppose that all its actions are for the purpose of balancing major powers.

H4 (Institutional Adaptation Hypothesis): When cooperation needs and industry complementarity are similar, the more complete the nuclear safety regulatory capabilities, technical standards coordination and contractual arrangements are, the more likely it is that the cooperation will be transformed from a document of intention into a project and mechanism with a record of continuous performance.

H5 (competing explanation): In some nuclear power construction projects, financing costs, commercial contracts, technology maturity and implementation cycles may have more direct explanatory power than macro geopolitical factors. If the evidence supports this explanation, this study will revise its judgment on the scope of political factors accordingly.

These propositions are hypotheses for empirical investigation, not findings established by the currently available documents.

4. Research Design and Evidence

4.1. Case selection and units of analysis

The study used codable item-level indicators. Cooperation models are classified by types such as uranium resources and nuclear fuel, nuclear power engineering and technology, supervision and capacity building; the degree of institutionalization adopts a four-level evidence sequence: policy declaration or intention, formal agreement, project arrangements with execution entities, observable continuous performance and system operation. Different types of cooperation do not add up mechanically horizontally.

Evidence corresponding to explanatory factors includes energy planning, government budget and power data, corporate equity and contract information, technical certification or licensing announcements, laws, regulations and regulatory cooperation activity records. Cross-check the time series evidence, focusing on whether policy changes precede cooperative decisions, whether cooperative arrangements have observable intermediate mechanisms, and setting up alternative explanations to control for selective attribution.

This study adopts a nested case study design that focuses on qualitative comparative research and is supplemented by policy texts and descriptive statistics. Kazakhstan and Uzbekistan are selected as core country cases, and specific projects or institutional cooperation arrangements are further selected within the countries. The two are in a similar Central Asian regional environment, and both have uranium industry-related foundations and policy agendas for the development of nuclear energy. However, the maturity of the industrial chain, the progress of nuclear power construction, and China's participation are different, so they are suitable for mechanism comparison.

The core case one is the Sino-Kazakhstan Ulba-FA joint venture nuclear fuel assembly project, which is used to analyze how complementary resources and technology, long-term purchase commitments, equity structures and technical certifications can form sustainable industrial cooperation; the second case is the selection process of Kazakhstan’s nuclear power construction partners, which is used to analyze national policies, commercial terms and international relations factors; the third case is China-Uzbekistan nuclear safety regulatory cooperation and the development of Uzbekistan’s nuclear power policy, which is used to

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analyze policy needs, institutional capabilities and cooperation boundaries. The above cases represent different types of cooperation, and unfinished nuclear power plants and fuel plants that have been put into production are not directly compared as "results" of the same level.

4.2. Sources and verification

The first type of information is policy and legal documents, including energy development strategies of China and the two countries, nuclear energy policies, intergovernmental documents, nuclear safety laws, regulatory norms and public project licenses. The second category is project and corporate information, including announcements, annual reports and joint venture project information of Kazatomprom, Ulba Metallurgical Plant and related Chinese companies. The third category is information from international organizations, including International Atomic Energy Agency infrastructure assessment data, nuclear safety standards and country reports from the World Nuclear Association. The fourth category is macro data, including electricity production and consumption, power generation structure, uranium production, related trade and infrastructure development indicators.

It is planned to establish a “policy event database” and a “cooperation project database”. Each record includes country, date, actor, cooperation category, summary of the matter, project stage, original source and verification status. For the same incident, try to cross-check original government documents, corporate announcements and international organization materials to form a traceable evidence chain. Based on Chinese and English materials, public materials in Russian and local languages will be gradually supplemented and key translations will be reviewed.

4.3. Comparative analysis and process tracing

The comparative study adopts a structured and focused design to uniformly answer questions such as "how policy needs are formed", "why specific partners are selected", "how institutional arrangements change implementation conditions" and "to what extent actual cooperation is advanced". Identify common mechanisms through cross-country comparisons, and identify differences in cooperation types through project comparisons within countries.

Process tracing focuses on reconstructing the timeline of policy and project events for each case. Taking the Ulba-FA project as an example, we sort out the early cooperation arrangements, joint venture construction, technical certification, production, first batch of supplies and production capacity expansion in order, and analyze the role of long-term contract procurement and quality certification in the sustainability of cooperation. For Sino-Ukrainian regulatory cooperation, the focus will be on tracking the regulatory reform background before the signing of the cooperation document and the actual training, institutional dialogue or capacity building results after the signing; if there is a lack of follow-up evidence, it will be truthfully determined that the relevant results cannot be verified.

4.4. Text coding, interviews, and validity

Policy text analysis establishes a coding manual around categories such as energy security, energy transition, industrial upgrading, partner diversification, nuclear safety, standards and capacity building. Through manual coding and NVivo or Python-assisted sorting, compare the policy statements and institutional priorities of nuclear energy development in different countries at different times. To control subjectivity, key original texts, coding rules and counterexamples will be retained, and double review will be conducted under appropriate conditions.

Descriptive statistics are used to present power structure changes, uranium resource production, related trade, investment and project progress. Considering the limited number of countries and projects and the differences in statistical calibers, small sample regression models are not used to directly infer the causal effects of complex nuclear energy diplomatic

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relations. Quantitative data are primarily used to confirm background trends and support case judgments.

Subject to the consent of the interviewees and research ethics approval, interviews are planned with energy policy researchers, regional and country scholars, and experts in the nuclear energy industry and regulatory fields. The interviews focused on the policy-making process, comparison of cooperation models, institutional barriers, and data interpretation, rather than on non-public technical parameters or confidential business information. Implement hierarchical management of interviewee identities, audio recordings, and citation authority; when interviews cannot be conducted due to objective conditions, systematic research on official documents and multi-source evidence will be used instead, and internal documents that are difficult to obtain will not be used as a prerequisite for completing the project.

First of all, clearly distinguish the five types of factual states of "policy intention-signing of agreement-construction implementation-completion of production-stable operation" to avoid inferring project completion from media titles. Secondly, set up contrary evidence for the core hypothesis: for example, there is strong complementarity but the cooperation has not been implemented, the political relationship is close but the business plan has not been adopted, or there is no identifiable implementation progress after the regulatory cooperation is signed. Thirdly, label the data years, statistical calibers and policy time points from different sources, and conduct alternative cases or sensitivity tests when necessary. Finally, prospective policy recommendations are not substituted for empirical findings, and study conclusions are consistent with the strength of the evidence.

5. Case Evidence and Comparative Expectations

5.1. Kazakhstan: nuclear fuel and proposed power generation

Central Asia is rich in energy resource endowments, but the energy structure and development priorities of the five countries are not consistent. Kazakhstan has an important uranium resource and nuclear fuel industry foundation, and its policy agenda includes both the extension of the resource product value chain and domestic nuclear power construction; Uzbekistan has uranium resources and growing power demand, and is promoting nuclear power construction and improving the nuclear energy regulatory system; Kyrgyzstan, Tajikistan, and Turkmenistan have different characteristics in their energy structure, infrastructure conditions, and policy agenda. Considering Central Asia as a whole as a single nuclear energy market, it is easy to ignore the differences between countries in economic development, institutional capabilities, technological foundations and foreign cooperation strategies.

Take Kazakhstan as an example. Information updated by the World Nuclear Association in October 2026 shows that the country has long been an important uranium producer in the world. In 2025, its uranium production was approximately 25,839 tons of uranium, accounting for approximately 40% of the global total. Its nuclear fuel assembly manufacturing capabilities have been substantially expanded, but commercial nuclear power construction projects still must distinguish different stages such as planning, contracting, and construction [4]. In Uzbekistan, the country information updated by the World Nuclear Association in October 2026 shows that nuclear power project planning includes reactors of different capacity levels and is linked to power demand, gas dependence and industrial upgrading issues in domestic policies [5]. These experiences provide a realistic basis for comparing nuclear energy development policies, industrial foundations and international cooperation paths in different countries.

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2021 and will reach the design production capacity of 200 tons of low-enriched uranium equivalent fuel assemblies per year in 2024. The products will be supplied to the Chinese nuclear power market [6]. This project involves equity arrangements, technology certification, long-term procurement and cross-border industrial chain collaboration, providing a good case for analyzing the institutionalization of cooperation. In contrast, China-Uzbekistan nuclear energy cooperation has made new progress in terms of supervision and capacity building. The Uzbek government announced in January 2026 that the Uzbek authorities and the China National Nuclear Safety Administration signed a memorandum of understanding on nuclear and radiation safety regulatory cooperation. The cooperation matters involve regulatory infrastructure, legal systems, and human resource training [7]. This is a formal arrangement for institutional cooperation, but its subsequent implementation results need to be tracked and verified.

5.2. Uzbekistan: power plans and regulatory cooperation

At the same time, there are Russian and other international players in the field of nuclear power construction in Central Asia. Kazakhstan's proposed nuclear power project and Uzbekistan's nuclear power construction plan show that the country may choose different partners in different industrial links [4][5]. The core question arising from this is not "whether China participates in cooperation", but "under what conditions, in what way China participates, and how can cooperation be institutionalized?" This issue has both international political economics explanatory value and China's energy foreign policy significance.

The Uzbek regulatory cooperation memorandum documents an institutional channel, but its implementation and effects require further verification [7]. Proposed nuclear power projects should likewise be classified by their observed stage rather than treated as completed investments [5].

5.3. Cross-case comparison

The preliminary comparison suggests that the cooperation portfolio differs by industrial segment and stage of implementation. Kazakhstan offers an observable nuclear fuel manufacturing project, whereas Uzbekistan supplies evidence of planning and regulatory engagement. A causal comparison requires systematic event coding, documentation of alternative partners, and verification of project milestones before stronger conclusions can be drawn.

6. Discussion and Policy Implications

This study does not prejudge all hypotheses to be true during the research planning stage, but defines the expected results as academic products and evidence materials that can be tested and submitted. First, establish a relatively systematic database of China-Central Asia civil nuclear energy cooperation policy documents and cooperation projects, presenting main policy changes, cooperation arrangements and project stages. Second, form an explanatory framework based on "national needs-international structures-institutional conditions" to reveal which factors help understand the choice of cooperation models in different industrial links and clarify its applicable boundaries. Third, two country cases of Kazakhstan and Uzbekistan and cross-case comparative results are formed to provide sufficient evidence to explain the differences in industrial chain cooperation and regulatory system cooperation. Fourth, form a doctoral thesis and phased research papers focusing on regional energy governance, nuclear energy industry chain cooperation or energy diplomacy. The specific submission plan will be determined based on the research progress and the quality of the results.

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In terms of policy application, it is planned to put forward conditionally binding suggestions from the aspects of identification of cooperation needs, project commercial risks, coordination of nuclear safety rules, capacity building and long-term institutional arrangements. The policy recommendations will clearly define the applicable countries, cooperation links and implementation prerequisites, and will not take the general expansion of nuclear power construction as a single policy goal.

Policy design should distinguish fuel-chain projects, nuclear power construction, and safety-regulatory cooperation. For each segment, cooperation proposals should specify financing, licensing, safety responsibilities, technical standards, implementation milestones, and public reporting. The appropriate mix depends on host-country priorities and institutional capacity.

7. Limitations and Conclusion

First of all, the research cases are mainly Kazakhstan and Uzbekistan, and it is difficult to directly generalize to all Central Asian countries or other regions. Secondly, the construction cycle of nuclear power projects is long. During the study period, some projects may still be in the negotiation or construction stage, and their long-term economic and environmental effects cannot be fully observed. Thirdly, some business contracts, financing details and policy decision-making information may not be made public, which may affect the judgment of specific motives. Finally, policy texts and project materials tend to have official narratives, and research needs to reduce bias through multi-source cross-checking and competitive explanations. For judgments that cannot be supported by independent evidence, the paper will retain uncertainty.

Civil nuclear cooperation in Central Asia cannot be inferred from resource endowments alone. National energy needs, industrial links, competing partners, and institutional arrangements jointly shape feasible pathways. The Kazakhstan and Uzbekistan cases provide a basis for structured comparison; future process tracing is needed to test the proposed mechanisms and assess longer-term outcomes.

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