INDIA'S ENERGY VULNERABILITY AND ITS NUCLEAR ENERGY POLICY TOWARDS CENTRAL ASIA SINCE 1991: A STUDY OF KAZAKHSTAN

Thesis Submitted for the Award of the Degree of

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in

Political Science

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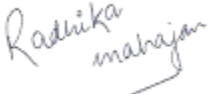
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2026

DECLARATION

I hereby declare that the work presented in the thesis entitled *"India's Energy Vulnerability and Its Nuclear Energy Policy Towards Central Asia Since 1991: A Study of Kazakhstan"*, submitted in partial fulfilment of the requirements for the award of the degree of Doctor of Philosophy (Ph.D.) in Political Science, is the outcome of my original research carried out under the supervision of Dr Birendri Singh, Assistant Professor, Department of Political Science, School of Liberal and Creative Arts (Social Sciences and Languages), Lovely Professional University, Punjab, India.

I further declare that this thesis embodies the results of my own investigations and has not been submitted, either in part or in full, to any other university or institute for the award of any degree, diploma, or equivalent qualification. Wherever the work described in this thesis is based on the findings of other researchers, due acknowledgments have been made in accordance with standard academic practice.



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CERTIFICATE

This is to certify that the work embodied in the Ph.D. thesis entitled *"India's Energy Vulnerability and Its Nuclear Energy Policy Towards Central Asia Since 1991: A Study of Kazakhstan"*, submitted in partial fulfilment of the requirements for the award of the degree of Doctor of Philosophy (Ph.D.) in the Department of Political Science, is the result of the original research work carried out by **Mrs. Radhika Mahajan** under my supervision.

I further certify that this thesis represents a bona fide record of the candidate's research work and that no part of this thesis has been submitted for the award of any other degree, diploma, or equivalent qualification in any other institution.



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ABSTRACT

Since 1990s, sustainable energy security has become a key component of India's foreign and security policy. Since 1991 economic reforms, the country's industrialisation and urbanisation have led to an unprecedented demand for energy, and increased reliance on imported sources for hydrocarbons and uranium. This led to economic and geo-strategic vulnerabilities in the face of the vagaries of the international market, supply constraints and maritime choke points in West Asia. Against this backdrop, India's energy security strategy required diversification of its energy partnerships, and an intensified engagement with the Central Asian region in particular, which has one of the world's largest uranium reserves, and a stable political environment for long-term partnerships specifically Kazakhstan. This study examines India's nuclear energy foreign policy towards Central Asia, with a particular case study of Kazakhstan, from 1991 to 2025. This research evaluates the development of India's civil nuclear diplomacy in relation to the country's energy security policy and how this relationship is indicative of the nature of India's effort towards strategic autonomy in the context of global power relations. This work suggests India’s foreign policy since 1991 has seen a shift in its structure-from passive energy procurement to active energy diplomacy-where nuclear engagement is a core element of its quest for resilience, diversification, and technological upgrades. The research employs a qualitative, historical-analytical approach enhanced by Critical Content Analysis. It uses primary sources such as the 2011 Indo–Kazakhstan Civil Nuclear Agreement, statements, and Ministry of External Affairs communications alongside data from 12 12 respondents selected using purposive sampling technique and secondary data from international think tanks, academic publications and policy bodies. The methodology allows for a critical mapping of policy development, institutional partnerships, and diplomatic progress, as well as an evaluation of implementation outcomes such as uranium acquisition, regulatory and multilateral integration. The research underlines that India's partnership with Kazakhstan is practically and symbolically significant in its nuclear power development. Pragmatically, the cooperation enabled India to secure a robust uranium supply after its 2008 waiver from the Nuclear Suppliers Group (NSG) legitimised its access to the global nuclear market while it is not a member of

the Nuclear Non-proliferation Treaty (NPT). At a symbolical level, the partnership marked India’s engagement with Central Asia as a viable energy partner, amid the region's multifaceted geopolitical environment of Russian dominance and Chinese Belt and Road Initiative (BRI). The 2011 civil nuclear accord formalised cooperation not just in resource sharing, but also in nuclear safety, waste management and joint research. The study also shows that Kazakhstan's geopolitical significance is not just due to its resource potential but also its geopolitical location as a neutral, multi-vector state that can engage with multiple great powers. India's strategy in Kazakhstan exemplifies a form of "soft balancing" - engaging in energy diplomacy while not alienating major regional players. India's energy diplomacy has been institutionalised through its Connect Central Asia initiatives and membership in the Shanghai Cooperation Organisation (SCO), thereby improving predictability and trust. But the study also highlights challenges. India's geographical distance from Central Asia, exacerbated by the Pakistan-Afghanistan corridor, poses a key challenge. Reliance on middlemen for uranium transportation and regulatory approvals further complicates the financial and administrative processes. Moreover, India's strategic autonomy is constrained by China's competition, which has significant infrastructural and investment ties with the uranium industry in Kazakhstan. The lack of parity between India's Department of Atomic Energy (DAE) and Kazakhstan's Kazatomprom also hampers project execution. Despite these challenges, India’s approach has evolved from transactional to strategic. The creation of joint working groups, bilateral summits and regular diplomatic exchanges since 2009 reflect policy stability and growing confidence. Further, India's adherence to International Atomic Energy Agency (IAEA) safeguards and non-proliferation measures reinforces its reputation as a safe and secure nuclear partner, something highly sought after by Kazakhstan. Thus, the partnership is a convergence of developmental and strategic interests-improving India's domestic nuclear energy goals while helping Kazakhstan diversify export markets away from Russia and China. The research also places Indo-Kazakh nuclear cooperation in the context of theoretical work on energy interdependence and regionalism. Based on the idea of complex interdependence and regional energy governance, the study views this collaboration as a case study of India's journey from energy importer to active energy player. The partnership signifies a multi-faceted relationship in diplomacy, technology and policy rather than simple trade in energy.

The study, chapter-wise, starts by framing India's post-liberalisation energy security and its logic of diversifying towards landlocked Central Asia. The second chapter traces the evolution of India's energy policy and connects it with the Connect Central Asia initiative and energy policy. The third chapter delves into the 2011 civil nuclear agreement - the decision-making process, uranium transactions and institutional arrangements. The fourth chapter analyses India's Central Asia policy in the context of a larger geopolitical environment led by China's Belt and Road Initiative (BRI) and Russia's Eurasian policy. The fifth chapter synthesises the research, and presents policy implications for improving infrastructure connectivity, institutional frameworks and multilateral cooperation in nuclear diplomacy. The research concludes that India's nuclear energy diplomacy with Kazakhstan is a critical part of its energy diversification and foreign policy diversification. It illustrates India's transition from being an energy importer susceptible to market shocks to a diplomatic leader in energy governance in its geopolitical neighborhood. However, the partnership's continuity is dependent on surmounting the logistical challenges, enhancing technological cooperation and maintaining policy consistency between India's energy policy apparatus and its foreign policy. Finally, the thesis highlights that India's engagement with Kazakhstan is a testament to a pragmatic combination of strategic and developmental pragmatism. This initiative promotes India's long-term ambition to secure clean, sustainable, politically stable energy, and its geopolitical influence in Eurasia. In a world marked by energy transitions, climate challenges and power shifts, this partnership offers a blueprint for emerging powers to achieve win-win outcomes through diplomacy, innovation and institutional trust.

Keywords – Energy Security, Nuclear Diplomacy, Central Asia, Indo–Kazakhstan Relations, Foreign Policy

DEDICATED TO

MY FATHER IN HEAVEN, WHOSE SPIRIT LIGHTS MY PATH;
MY MOTHER, WHOSE LOVE SUSTAINS ME;
MY HUSBAND AND MY SON, WHOSE PRESENCE FILLS MY WORLD WITH PURPOSE AND PEACE.

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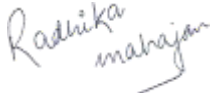
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I dedicate this thesis to all of them with heartfelt gratitude.



(Signature of Candidate)

RADHIKA MAHAJAN

DATE: 31.08.2026

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ABBREVIATIONS

Abbreviation	Full Form
ADB	Asian Development Bank
ADBI	Asian Development Bank Institute
BRI	Belt And Road Initiative
CARS	Central Asian Republics
CCAP	Connect Central Asia Policy
CGN	China General Nuclear Power Group
CIS	Commonwealth Of Independent States
DAE	Department Of Atomic Energy
FDI	Foreign Direct Investment
GHG	Greenhouse Gas
GW	Gigawatt
IAEA	International Atomic Energy Agency
IEA	International Energy Agency
INSTC	International North–South Transport Corridor
IOR	Indian Ocean Region
JWG	Joint Working Group
KAZATOMPROM	National Atomic Company Kazatomprom (Kazakhstan)
LEU	Low Enriched Uranium
LNG	Liquefied Natural Gas
LPU	Lovely Professional University
MEA	Ministry Of External Affairs (India)
MGNREGA	Mahatma Gandhi National Rural Employment Guarantee Act
MW	Megawatt
NITI	National Institution For Transforming India
NPT	Nuclear Non-Proliferation Treaty
NSG	Nuclear Suppliers Group
OECD	Organization For Economic Co-Operation And Development
ORF	Observer Research Foundation

PHWR	Pressurized Heavy Water Reactor
R&D	Research And Development
SCO	Shanghai Cooperation Organization
TAPI	Turkmenistan–Afghanistan–Pakistan–India (Pipeline Project)
TERI	The Energy And Resources Institute
UN	United Nations
UNEP	United Nations Environment Programme
USD	United States Dollar
WTO	World Trade Organization

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CHAPTER 1
INTRODUCTION

1.1 Introduction

India's energy security has acquired increasing strategic importance in the context of rapid economic growth, industrialisation, urbanisation and the country's transition towards a lower-carbon development pathway. The expansion of energy demand has occurred alongside structural constraints arising from limited domestic reserves of several conventional energy resources, import dependence, infrastructure limitations and exposure to geopolitical disruptions. Consequently, India's energy policy has increasingly moved beyond the narrow objective of ensuring adequate supply towards a broader strategy of diversification, resilience, technological capability and strategic autonomy.

Within this broader energy-security framework, nuclear energy occupies a distinctive position. Nuclear power offers the potential to provide relatively stable baseload electricity while contributing to the diversification of India's energy mix and the reduction of dependence on fossil fuels. However, the expansion of India's civilian nuclear programme is closely linked to the availability of nuclear fuel, particularly uranium. India's limited domestic uranium resources have therefore encouraged the development of international nuclear partnerships and long-term supply arrangements. The transformation of India's access to the international nuclear market following the 2008 Nuclear Suppliers Group waiver created an important enabling environment for the expansion of civil nuclear cooperation.

India-Kazakhstan nuclear cooperation began in the early 2000s, as India sought to realign itself after the 1998 nuclear tests, and to gain international acceptance for its civilian nuclear program. Negotiations gained traction following the U.S.–India Civil Nuclear Agreement and the 2008 NSG waiver, which allowed India to participate in civil nuclear trade while remaining non-member of the Non-Proliferation Treaty (NPT). India and Kazakhstan inked a civil nuclear deal in April 2011 during Prime Minister Manmohan Singh's visit to Astana. This allowed Kazakhstan to export uranium to India and work on peaceful applications of nuclear energy. Kazakhstan provided India with 5,000 metric tons of uranium from 2015-19, strengthening India's fuel security and uninterrupted operation of Pressurized Heavy Water Reactors (PHWRs). This remains crucial for India to reach

100 GW nuclear capacity by 2047.

India's nuclear agreement with Kazakhstan is driven not just by considerations of energy security, but also by the strategic dynamics of regional geopolitics. Given China's increasing involvement in Central Asia through the Belt and Road Initiative (BRI)-with massive investments in the energy, logistics and infrastructure Sectors-India is confronted with the challenge of energy security and strategic assertion. In response, India has linked its energy diplomacy to other foreign policy initiatives, such as the International North-South Transport Corridor (INSTC) and Chabahar Port in Iran, to circumvent Pakistan and link with Central Asia through Afghanistan and the Caucasus. These initiatives are designed to advance India's geographical connectivity to Central Asia and decrease the constraints of energy commerce, especially uranium and hydrocarbon imports. Therefore, India's nuclear deal with Kazakhstan is also a diplomatic countermeasure to China's influence in the region and India's desire to be a part of the great power game in Eurasia.

Acknowledging the need to diversify its nuclear fuel sources, India's nuclear power policy has given greater importance to engagement with Central Asian republics. A uranium-rich and politically open to non-aligned partnerships, this region provides potential future sources, supplementing existing Western and West Asian suppliers. India's engagement with Central Asia has been influenced by the "Connect Central Asia" policy launched in 2012, which prioritises energy cooperation (including civil nuclear power agreements) with Central Asian nations. Kazakhstan, with its abundant uranium deposits and political stability, is a partner of particular interest; but India has also made preliminary overtures to Uzbekistan and Kyrgyzstan. This is part of India's energy diplomacy to secure uranium imports, collaborative nuclear research and peaceful use agreements with these nations.

Energy is the key factor for development of any country. India's high economic growth demands energy as a basic factor of ensuring sustainable growth. During the last thirty years India transformed from an agricultural nation into a service-based economy and industrial economy. The transition has resulted in an explosive growth of energy usage. The International Energy Agency (International Energy Agency, 2024, p. 17) predicts India will experience the largest energy demand growth among all nations during the next fifty years (International Energy Agency, 2024). The present path toward energy access has become essential for national security because of middle-class expansion and

urbanization and digitalization trends.

Despite this surging demand, India's domestic energy production has not kept pace. According to the Ministry of Statistics and Programme Implementation (Ministry of Statistics and Programme Implementation, 2023, p. 23), The total energy consumption in India for 2021-22 amounted to 33,508 petajoules which marked a 10.39% increase from the previous year. The nation holds a minimal 0.27% share of global known oil and gas reserves despite its large population of over 17%. The energy economy of India faces a fundamental structural problem because it depends on imported crude oil to meet more than 80% of its needs. The country faces numerous risks because of its heavy dependence on foreign energy supplies which makes it susceptible to price fluctuations supply chain breakdowns and geopolitical instabilities from the unstable West Asian energy suppliers.

Since the 1991 economic liberalization, India has implemented a comprehensive energy strategy to overcome its energy vulnerabilities. The energy strategy consists of multiple elements such as adding new supply sources while expanding domestic oil exploration efforts promoting renewable energy adoption and cultivating better relationships through global energy diplomacy. Nuclear energy has been one of these that are being seen as a viable alternative. It provides a low-carbon and high-output energy source that can be vital in alleviating environmental as well as strategic issues. The Indian government, though, intends to significantly raise the amount of nuclear power donation to India, with currently, about 2% of electricity generation in India being donated by the nuclear power. In India, the government has a target of 100 GW nuclear capacity by 2047 as per policy objectives as per the Department of Atomic Energy (Press Information Bureau, 2025, p. 9).

Nevertheless, the growth of nuclear power facilities necessitates safe and stable supplies of nuclear fuel-mainly uranium. Considering the comparatively small domestic uranium reserves in India, the nation has tried to find international collaborations to realise its nuclear aspirations. In this regard, Central Asia, especially Kazakhstan, plays a strategic role. Kazakhstan is the largest producer of causative Uranium.over 40 percent of world supply (World Nuclear Association, 2023, p. 5). Its huge resource deposit and stable government make it a dependable ally to nations such as India that have long-term nuclear policy.

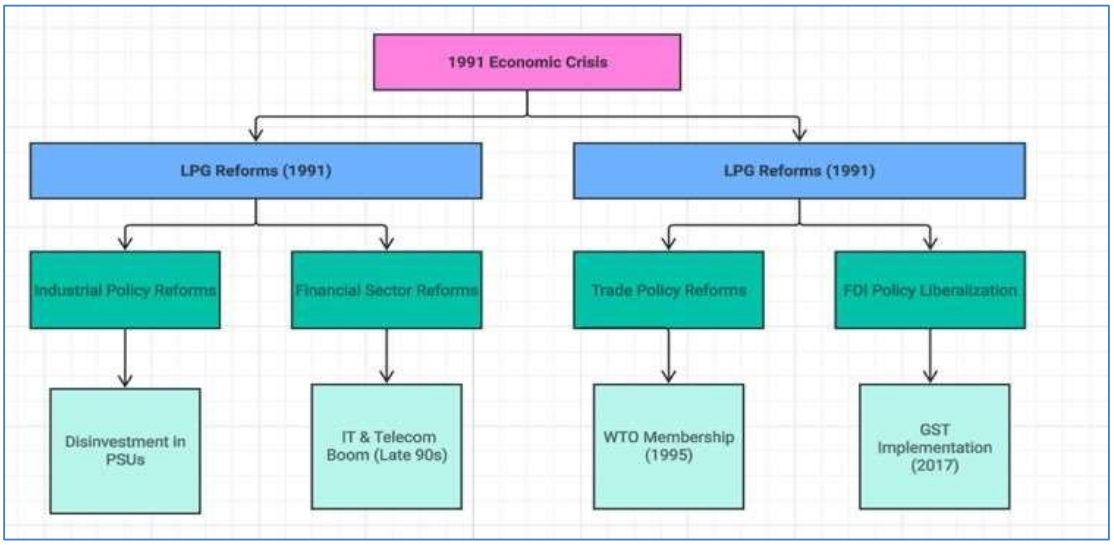
India’s engagement with Kazakhstan in the nuclear domain dates back to the early

2000s but gained significant momentum with the signing of the Indo-Kazakh Civil Nuclear Agreement in 2011. This agreement formalized during the visit of Prime Minister Manmohan Singh to Astana, set the stage for long-term cooperation in uranium supply and peaceful uses of nuclear energy (Department of Atomic Energy, 2011, p. 12). The framework allowed Kazakhstan to provide 5,000 metric tons of uranium to India from 2015 to 2019 which supported India's nuclear fuel stability. The sustainability of international nuclear transactions depends on the common commitment from both parties to non-proliferation standards and international safeguard measures.

The framework of India's "Connect Central Asia" policy has expanded Indo-Kazakhstan relations beyond their energy trade activities. The 2012 policy initiative seeks to boost India's political economic and cultural ties with Central Asia because the area stands vital in the emerging global multipolar system (Drishti IAS, 2019). The strategic position of Kazakhstan as well as its abundant resources and stable political environment makes it the essential foundation of this policy. The bilateral cooperation consists of energy trade and defense relations with education and cultural engagement which strengthens their strategic partnership.

However, challenges remain. The lack of direct land access, as a result of the strategic denial of Pakistan, a destabilized security situation in Afghanistan, restricts the possibility of smooth logistics. The proposed developments of Chabahar Port and the International North-South Transport Corridor have potential but are experiencing operational development issues coupled with regional power tensions. China and Russia are major powers in Central Asia and this poses a great competition to India. Massive energy and infrastructure projects have been deployed by the Belt and Road Initiative of China (BRI) to entrench Chinese influence across Central Asia and especially in Kazakhstan. Russia has historical security obligations. Through membership in such organizations as the Collective Security Treaty Organization (CSTO) and the Eurasian Economic Union (EAEU) with the Central Asian republics. India must exercise prudent planning in expanding its regional presence owing to these regional dynamics (Sage Journals, 2022).

Figure 1.1: Evolution of India's Economic and Energy Policy Since 1991



This chronology highlights important steps in the process of the Indian economy becoming less agrarian and more diversified, with an energy-dependent service and industrial economy. It identifies key policy changes, such as opening up the economy, green energy efforts, and nuclear collaboration, including the Indo-Kazakhstan civil nuclear agreement of 2011. The other complication is the local regulatory and investment climate in the Indian nuclear industry. In the past, India has limited foreign investments in its nuclear energy sector, because of liability issues. Nevertheless, proposed changes to the Atomic Energy Act (1962) and the Civil Liability for Nuclear Damage Act (2010) will open up this industry and enable more outsourcing and foreign involvement in the industry (Reuters, 2025). These changes are essential to the expansion of nuclear capacity, as well as, to ensure that strategic partnerships such as that between the two countries like Kazakhstan and the United States are commercially viable and sustainable.

The junction of Indian energy vulnerability and its foreign policy towards Central Asia- and especially Kazakhstan offers a good study subject. Nuclear energy and other alternatives could be the key to an energy-secure and low-carbon economy in India as it strives to become an energy-sufficient nation co-operation by the world in supplying uranium will be vital elements of its strategy. The fact that Kazakhstan is a stable and resource-based partner augurs well in the prospects of having a mutually beneficial relationship. However, to achieve this potential, infrastructural, regulatory, and geopolitical obstacles must be overcome. This paper will, thus, critically examine how Indo-Kazakh nuclear cooperation has evolved, its present condition and future perspectives in the

context of the overall energy security policy of India.

1.2 Importance of Energy in India's Economic Growth

Rapid industrialization and urbanization and population growth in India has led to the increase of national energy demands in great proportions. Energy is very important to the economic development of a country since it influences the manufacturing process as well as the service delivery industries. By 2050, India will lead the world in energy demand to the International Energy Agency due to the rising incomes and population growth and urbanization and industrial growth as per their projections (International Energy Agency, 2024, p. 17). This increasing energy requirement highlights the necessity of diversified and sustainable energy portfolio to sustain the further economic growth and reduce environmental consequences.

India’s Rising Energy Demand vs. Domestic Supply Constraints

As the world's 3rd-largest energy consumer India struggles to fulfill its energy needs by producing energy domestically. India faces international political hazards and market price fluctuations because it depends greatly on imported fossil fuels including natural gas and crude oil. In 2021-22 India utilized 33,508 petajoules of energy while experiencing total energy consumption growth of 10.39% over the previous year (Ministry of Statistics and Programme Implementation, 2023, p. 23).

The country's high level of import dependency puts strain on both the balance of trade and creates challenges for securing a stable energy supply. India has started to explore new energy sources and international energy partnerships because its growing energy requirements exceed its domestic energy production capacity.

Role of Nuclear Energy and Global Partnerships

The Indian government uses nuclear energy as a fundamental element to secure its energy needs while pursuing low-carbon economic development (Selvam et al., 2025). Nuclear power generates about 2% of India's total electricity production at present. The government has established a purposeful objective to develop nuclear power facilities from their present capacity of two per cent to reach one hundred gigawatts by 2047 to decrease carbon emissions & decrease dependance on fossil

fuels. (Press Information Bureau, 2025, p. 9).

To realize this goal, India is considering policy reforms to attract private and foreign investments in the nuclear sector. Proposed amendments to the Civil Liability for Nuclear Damage Act of 2010 and the Atomic Energy Act of 1960 aim to facilitate greater participation from domestic private players and international partners. These reforms are expected to accelerate the development of nuclear infrastructure and enhance technological collaboration.

Why Central Asia, Especially Kazakhstan, is Geopolitically and Energetically Relevant

Central Asia, a region rich in energy resources, is strategically significant to the Indian energy diversification process. Kazakhstan especially is the largest Uranium producer in the world and has been a steady supplier to India. In 2015–2019 Kazakhstan sold 5,000 metric tons of uranium to India, which was a significant source of Indian nuclear fuel needs (World Nuclear Association, 2023, p. 5).

This bilateral relationship between India and Kazakhstan has also been entrenched with the signing of a civil nuclear agreement in 2011 that includes the sale of uranium and cooperation in the peaceful use of nuclear energy (Department of Atomic Energy, 2011, p. 12). This alliance is in line with the Indian policy of connect central Asia which aims at strengthening political, economic and cultural relations with the Central Asian countries. This partnership has not yet reached its maximum potential. Customers face barriers from energy sector infrastructure constraints as well as administrative barriers and regional power dynamics between major nations which constrain energy cooperation initiatives. Energy security together with foreign policy and regional geopolitics need a detailed comprehension to solve existing challenges.

1.3 Statement of the Problem

The energy sector of India maintains a weak foundation even though the country achieved significant economic growth throughout the past thirty years. India stands as the world's third-largest energy consumer but its 1.4 billion citizens face energy shortages because the country does not have enough domestic energy resources. According to the Ministry of Statistics and Programme Implementation (2023), reports that India consumed

33,508 petajoules of total energy in 2021–22 while imports have steadily increased to fulfill this demand. More than 82 percent of the crude oil and 45 percent of the natural gas supply in India is imported and West Asia is the leading supplier of these imports. The overdependence on imported energy poses a major threat to India since it will be subject to global turbulence and oil prices and diplomacy. The Iran-US confrontation and attacks on Saudi oil fields and Red Sea shipping crisis have resulted in fuel shortages and high oil prices which directly affect inflation and foreign exchange level in India.

Although West Asia remains at the top of the importation matrix of India, this is due to its long history of chronic instability that is calling on the need to diversify. The region of Central Asia with its deposits of oil, gas, and uranium is a promising alternative. But access to these resources is crippled in India by both geography and geopolitics. India does not have any direct border with Central Asian republics and overland routes are mostly inaccessible because of strained relations between India and Pakistan and current security problems in Afghanistan. The conflicts have been paralyzing projects like Turkmenistan-Afghanistan-Pakistan-India (TAPI) pipeline which is a great project. Other connectivity plans such as the International North-South Transport Corridor (INSTC) and the establishment of Chabahar Port in Iran are also hampered by sanctions, lack of funding and logistical challenges.

Kazakhstan is one of the most important countries of Central Asia. Not only is it the largest landlocked country in the world, it is also the largest producer of uranium with more than 40 percent of the world production. Having acknowledged this, in 2011, India and Kazakhstan have signed a civil nuclear cooperation agreement with the view to guarantee a consistent supply of uranium and develop peaceful uses of nuclear energy (Executive Agreements Database, 2022). Kazakhstan also provided more than 5,000 metric tons of uranium to India between 2015 and 2019. The bilateral relationship has however not been able to achieve its full strategic potential. It has not been implemented quickly and wider nuclear cooperation has not been developed yet, as there are various challenges to this process, including poor transport infrastructure, the regulatory restriction of India, and the growing competition with China, which has poured into the energy and transport industry of Kazakhstan as part of its Belt and Road Initiative (Ministry of External Affairs, Government of India, 2009).

The current nuclear energy power of India that makes up approximately 2 percent

of the total power generation is proposed to reach 100 GW by 2047. The importation of fuel and international collaborations is of paramount importance in achieving this target. However, lack of a well-developed logistical network between India and Kazakhstan restricts the full implementation of the civil nuclear deal. Moreover, the Indian domestic policy landscape, which has hitherto been hostile to foreign investment in nuclear energy has not allowed further cooperation. The proposed changes to the Civil Liability for Nuclear Damage Act (2010) and the Atomic Energy Act (1962) are expected to open up the industry and attract foreign and domestic investors, although the reforms remain in their infancy.

Therefore, the energy policy in India is at crossroads. The necessity to shift towards over-reliance on West Asian hydrocarbons to a more diversified and balanced energy profile is pressing. Central Asia and more specifically Kazakhstan is an option to move ahead since it has resources in nuclear fuel, political stability and historic links with India. Nevertheless, this potential has not been actualized because of the combination of infrastructural deficiencies, lack of connectivity and underutilized diplomatic systems. These problems are not only critical to the energy security of India but also to increasing its strategic reach in Eurasia, countering the rising presence of China, and strengthening India's dedication to less carbon energy sources (World Nuclear News., 2011).

1.4 Persistent Energy Insecurity in India

India is characterized by a huge imbalance between the supply and demand of energy. Although the country is the third largest energy consumer in the world, it only produces a small proportion of the energy it uses. In 2021-22, the total energy consumption in India was 33508 petajoules, which is 10.39 per cent higher than last year. Nonetheless, India has a mere 0.27% of the world oil and gas reserves yet has 17 percent of the total global population, which means that it is highly structurally dependent on imports.

The electricity generation of India is very dependent on coal (51.7%), whereas oil and gas are the greatest sources of energy imports. Besides, rising industrialization, rural electrification, and growing urban population are pushing energy demand exponentially - it is estimated that it will grow twofold by 2040 (International Energy Agency, 2024, p. 17).

The absence of sufficient domestic resources puts the country in a desperately weak situation, where it cannot obtain continuous, cheap energy on its own (Eurasian Research Institute, 2020).

Overdependence on West Asia and Its Instability

The energy system of India is largely dependent on West Asian nations with more than 60% of crude oil imports being derived in the Gulf region. The major suppliers have been countries such as Iraq, Saudi Arabia and Iran. Nevertheless, the geopolitics in the area, such as the wars in Syria, Yemen, and Iraq, and the tension with Iran, are posing threats to the energy security on a regular basis.

Such overdependence was revealed in such events as the Iraq War, Arab Spring and the US-Iran nuclear confrontation that resulted in a sudden rise of oil prices in the world market and in interrupted trade flows. Further escalation is the Red Sea shipping crisis that occurred in early 2024 emphasized the direct effects of regional instability on the energy economy of India (Reuters, 2024). This has led to the recurrent fiscal shocks, inflationary pressures, and trade deficits in India caused by the costs of energy imports. (Ministry of External Affairs, Government of India, 2023).

Limited Physical Access to Central Asian Energy Sources

As much as Central Asia provides a viable alternative source of energy, India is subject to huge logistic and political obstacles in tapping into this region. Central Asia is landlocked and India does not have a direct boundary with any of the five Central Asian republics. The old access routes through Pakistan and Afghanistan have been destroyed or insecure as a result of bad diplomatic relations and continuing conflict.

Another example of promising projects, the Turkmenistan-Afghanistan-Pakistan-India (TAPI) pipeline, has been delayed because of the security situation in Afghanistan and the poor India-Pakistan relations. Other regional connectivity projects such as the International North-South Transport Corridor (INSTC) and the Chabahar Port in Iran are either poorly developed or have got limitations due to international sanctions.

Such infrastructural limitations have slowed down or reduced the feasibility of big

scale continuous energy supply between Central Asia and India. This weakness still exists despite the diplomatic good will and energy agreements with major countries such as Kazakhstan and Turkmenistan.

Underutilization of India-Kazakhstan Nuclear Potential

Kazakhstan, the largest uranium producer in the world is a key player in Indian nuclear energy plan. In 2011, India and Kazakhstan entered into a civil nuclear agreement as part of nuclear cooperation, which allowed the supply of uranium and peaceful nuclear energy cooperation. Between 2015-2019, Kazakhstan has provided more than 5,000 metric tons of uranium to India (Department of Atomic Energy, Government of India, 2011).

Despite this foundation, the strategic potential of the relationship remains underutilized. Several barriers have impeded expansion:

- The lack of direct transport routes to Kazakhstan limits logistics and adds to costs.
- Competition from China in Kazakhstan's energy and uranium sectors has grown stronger through the Belt and Road Initiative.
- India's domestic nuclear regulations have until recently restricted foreign investment, creating obstacles to integrated energy infrastructure development.
- Bureaucratic delays and underdeveloped private sector involvement also hinder the operationalization of long-term nuclear collaboration.
- This disparity between the diplomatic assent and practical application has limited what might otherwise be a dependable, long-term energy source to India - particularly with the necessity to augment clean energy generation and to decrease carbon releases.

1.5 Objectives of the Study

This study aims to critically assess the place of nuclear energy in the overall Indian approach to counter energy insecurity and its bilateral energy relationship with Kazakhstan. The specific objectives of the research are:

1. To assess the scope and strategic relevance of Central Asia’s energy resources,

particularly uranium

2. To examine the evolution and current status of the India–Kazakhstan civil nuclear partnership
3. To analyze the geopolitical and infrastructural challenges affecting India's access to Central Asian nuclear resources
4. To compare India's energy diplomacy in Kazakhstan with the influence of external powers such as China and Russia
5. To propose viable strategies for India to enhance nuclear cooperation with Kazakhstan and the broader Central Asian region

1.6 Research Questions

1. To what extent is Central Asia a viable long-term source for India's nuclear energy needs?
2. What are the achievements and limitations of the India–Kazakhstan nuclear cooperation agreement since its inception?
3. How effectively can Kazakhstan's uranium reserves contribute to India's target of 100 GW nuclear capacity by 2047?
4. What geopolitical and infrastructural barriers constrain India's energy outreach in Central Asia
5. What strategic measures can India adopt to counter competing regional influences and strengthen its nuclear diplomacy?

1.7 Tentative Assumptions

- TA1: The India-Kazakhstan civil nuclear pact offers a sustainable platform of strengthening bilateral energy security and strategic partnership.
- TA2: Enhanced nuclear cooperation with Kazakhstan will help India to achieve its clean energy expansion objectives and regional political power.

1.8 Significance and Rationale of the Study

The Indian quest of energy security is closely associated with its future economic development, environmental responsibilities and strategic placement in a multipolar international system. Being one of the rapidly expanding economies, the growing energy demand in India, which is to increase twofold by 2040, requires a diversified, stable and low-carbon energy portfolio. Nuclear energy has become a fundamental part of this transition as it has high base-load capacity and low carbon footprint.

Nonetheless, the small reserves of uranium in India render the country highly reliant on foreign sources of fuel. Kazakhstan is a strategically important partner as the largest uranium producer in the world. Indo-Kazakhstan civil nuclear agreement signed in 2011 provided a basis of peaceful nuclear relations and long term uranium supply. In 2015-2019, Kazakhstan sold more than 5,000 metric tons of uranium to India, which contributes to the functioning of nuclear reactors in the country. It has continued to be at the core of India achieving 100 GW of nuclear power capacity by 2047.

In addition to the bilateral aspect, the work is important to learn how the energy diplomacy of India overlaps with the Indian geopolitical interests. Central Asia has become an important energy frontier, particularly with India trying to find an alternative to unstable West Asian energy lanes. In these respects, political stability and the abundance of resources in Kazakhstan provide India with a fuel security and regional strategic advantage.

Additionally, the increasing strength of China via projects such as Belt and Road Initiative (BRI) has posed competitive factors in the area. The Indian alliance with Kazakhstan is an indication of a larger effort to establish its presence in Central Asia and diversify its strategic reliance. The paper also identifies the changing nuclear diplomacy-based on non-proliferation norms and civil nuclear cooperation-as a tool to improve its international reputation beyond the Non-Proliferation Treaty (NPT) framework as a country.

The study is also preconditioned by the comparative scholarly underestimation of operational and implementation issues of Indo-Kazakh nuclear cooperation. Although the deal is thoroughly reported in official channels, the deal has some critical loopholes in the academic appraisal of its implementation, regulatory bottlenecks and connectivity constraints. Filling these gaps has been part of policy discourse and international energy

diplomacy research.

Energy Transition and Domestic Imperatives

The energy requirements in India will expand rapidly because of urbanization and industrialization together with the rapid growth of the middle class. The transition to sustainable energy solutions requires India to focus on nuclear energy as its primary alternative energy source (Prajapati et al., 2025). The government seeks to reach 100 GW of nuclear power generation capacity by 2047 while following its path toward zero emissions. The nuclear energy program will experience accelerated development through recent policy changes which allow up to 49% foreign direct investment in nuclear power plants.

Strategic Engagement with Central Asia

The region of Central Asia provides India with abundant energy resources that functions as its main partner in establishing energy diversification strategies. Kazakhstan stands as the globe's leading uranium producer which makes it essential for supplying India's nuclear reactor operations. Uranium supply along with peaceful nuclear cooperation between India and Kazakhstan entered into force through their civil nuclear agreement from 2011. The strengthened partnership with this region provides India with stable uranium supplies while expanding its geopolitical influence in a region dominated by major powers.

Counterbalancing China's Regional Influence

The Belt and Road Initiative (BRI) launched by China has boosted its activities in Central Asia by creating infrastructure developments as well as energy infrastructure and strategic initiatives. The expanding Chinese influence creates obstacles for Indian interests in the region. India can establish itself as a major regional power by strengthening both energy and strategic relations with Central Asian countries particularly Kazakhstan to counter China's growing influence in the region. By implementing collaborative projects and diplomatic engagements through "Connect Central Asia" India promotes its regional presence. (Embassy of India, Astana, 2025).

Advancing Nuclear Diplomacy

India expanded its nuclear diplomacy by integrating both strategic powers and international non-proliferation obligations with its energy security requirements. The nuclear cooperation with Kazakhstan helps India demonstrate its responsible nuclear status while creating new possibilities for joint work in nuclear science and technology research and safety protocols. Through this engagement India supports worldwide initiatives to use nuclear energy peacefully while dealing with climate change problems.

1.9 Review of Literature

The review is literature holds the vital space in the realm of academic discourse. In context to present study, the research seeks to understand the changing dynamics of India's energy scenario with particular focus in emerging dynamics of Nuclear Energy. In this milieu, the present section seeks to understand the emerging trends, India's energy vulnerability, geo-political perspectives from holistic perspective. Therefore, the literature has been presented under appropriate themes as outlined below:

Theme 1: India's Energy Vulnerability and Strategic Transition

This section talks about the high dependence on imported fossil fuels in India, and the structural and geopolitical weaknesses that the situation presents to the country. Significant literature (e.g., Singh, 2010; Chakraborty et al., 2021) highlights the importance of diversifying, with nuclear and renewable energy options being the priorities. The literature highlights how policy reforms, infrastructure advancement, and strategic reserves can enhance India energy resilience.

The issue of energy security in India has become a crucial strategic and economic concern in the 21st century. The two concomitant energy issues that must be addressed in the country are the high levels of industrialization, urbanization and increasing middle class that require a dependable energy supply and sustainable low carbon transition. As has always been the case in academic literature, the vulnerability of India energy has never been a supply problem but a multidimensional issue that is affected by structural dependence on imports, technological limitations, and geopolitical vulnerability.

Singh (2010) concentrates on the fact that India is increasingly relying on imported oil but emphasizes that it is important to diversify its energy demands as a strategic move.

Similarly, Dadwal (2007) and Sharma (2007) put the energy crisis in India in a global perspective of rising demand in the less developed economies and suggest strategic reserve requirement, increased efficiency and regional energy cooperation. This point of view is also supported by Pant (2007) who quantitatively demonstrates the growing discrepancy between demand and supply and advances the notion of the Gulf being not the only way to go. All these preliminary studies put in place the foundations of knowledge that the energy insecurity crisis in India is entrenched in the structural economic transformation of the nation.

Building on this, Mohan (2009) links energy policy with foreign policy, arguing that energy security must be elevated to a core diplomatic priority. This view point is a significant change in considering energy as a domestic economic problem to the consideration of it as a foreign policy tool. Simultaneously, Chakraborty et al. (2021) discuss technical inefficiencies in power distribution systems, noting infrastructural deficiencies in transmission losses and grid inefficiencies as the main factors contributing to energy vulnerability. Kulkarni and Katti (2012) add to this by showing using economic modelling that diversification into natural gas and nuclear systems is economically and environmentally beneficial.

More recent studies have expanded this discourse by incorporating sustainability and technological transition into the analysis (International Atomic Energy Agency, 2024). Jhalanim, Bose, and Rao (2023) promote the idea of policy simulations, which promote the idea of a fast transition to nuclear and renewable energy supported by international collaboration. Correspondingly, Barbar et al. (2023) emphasize the significance of energy storage systems in stabilizing the Indian electricity grid, especially with regard to the growing renewable penetration. Raj and Sharma (2024) also show the direct effects of global energy price volatility on the macroeconomic stability of India, which supports the view that energy vulnerability affects both the domestic and international levels. Policy based studies in the recent years also indicate that nuclear energy will probably be instrumental in fulfilling the long term energy security and decarbonization objectives in India, especially with its capacity targets of 2047. (Carnegie Endowment, 2024; International Energy Agency, 2025).

Besides these contributions, the literature has some limitations. Much of the available literature is inclined to consider energy vulnerability as a matter of dependence on imports

and infrastructure deficit, but not much consideration is addressed in terms of nuclear diplomacy and external alliances in alleviating these vulnerabilities. Also, the technical analyses of energy systems and geopolitical interpretations of energy strategy are not well integrated.

The literature is therefore a complete picture of the energy dilemma in India but it is scattered in the economic, technical and geopolitical spheres. This paper expands upon these observations by incorporating energy vulnerability and nuclear diplomacy and strategic engagement, especially in the case of Central Asia and Kazakhstan.

Theme 2: India's Energy Diplomacy in Central Asia

This section explores how India's foreign policy has evolved to include energy cooperation with Central Asia. Historians such as Dash (2013) and Ahmed (2009) trace the historical background and strategic reasons of the initiative of connect central Asia. The literature singles out logistical, political, and institutional constraints that inhibit an effective interaction of India with the region.

The development of Indo-Central Asia energy diplomacy can be seen as the strategic move of India to diversification of energy sources, mitigating the unequal balance of power in the region, and strengthening the Indian foreign policy position. With its hydrocarbons and uranium, Central Asia has become a center of the Indian energy outreach especially following the liberalization of the Indian economy in 1991. A vast majority of this literature concurs that Indian interest in Central Asia is not based solely on the resource imperative but also by geopolitical interests and the urge to gain strategic autonomy.

One of the first in-depth analyses of the strategic implications of energy diplomacy in West and Central Asia was given by Ahmed (2009). He believes that the huge energy reserves available in the region have led to great-power politics and altered the foreign policy priorities of India. Likewise, Bisaria (2013) concentrates on the policy of the Connect Central Asia as a diplomatic framework, emphasizing its economic, technological and energy aspects. Nonetheless, he also observes that although institutional mechanisms had been set in place, real energy projects had been slow in coming about because of infrastructural and logistical bottlenecks. Dash (2013) adds to this analysis by placing the Indian involvement in the context of the general political shift of the post-Soviet world, and the significance of the similarity of historical and political experience in the formation

of cooperation.

Additional contributions show the operational and strategic constraints of Indian energy diplomacy. Jaiswal (2018) criticizes the Indian attitude toward the slow policy reactions and insufficient investment in strategic infrastructure, especially in contrast to the case of China that actively participated in Central Asia. Mahalingham (2006) also highlights the issues surrounding the pipeline diplomacy whereby the pipeline projects such as the TAPI have been stalled due to issues of security and instability in the region. Patnaik (2010) introduces an aspect of comparison by showing how the presence of China in terms of institutions and infrastructures has surpassed that of India, restricting the influence of India despite similar cultural and historical connections. Shah (2013) also reinforces the importance of regional cooperation framework, implying that multilateral efforts are crucial in breaking geopolitical barriers.

Later scholarship has elaborated on this discussion by adding dynamic geopolitical relations and issues of connectivity. GROZIN (2024) suggests a more modern approach and discusses the role of India in Eurasian energy and transport corridors as a factor that is more and more important in terms of decreasing reliance on maritime routes and improving connectivity between continents. In the same light, recent researchers emphasize the increasing significance of alternative connectivity projects like the International North-South Transport Corridor (INSTC) and Chabahar Port, but their application is limited due to geopolitical tensions and infrastructural constraints (Kalyuzhnova and Holzhacker, 2021; Kaulgud, 2022). The role of global geopolitical changes, specifically the Russia-Ukraine conflict, in transforming energy flows and making Central Asia more strategically important in the global energy webs, is also emerging as an important factor in the analysis. (FPRI, 2024).

In this more general context, Supyaldiyarov (2024) offers a dedicated analysis of the energy relations between India and Kazakhstan with reference to the latter as a trusted uranium exporter and a potential partner in the further technological and institutional cooperation. His examination highlights the importance of India enhancing its involvement in Eurasian energy conferences and institutionalization of energy partnerships to ensure long-term energy relations.

With these contributions, a gap between the intent of the policy and its implementation is present across the literature. Although India has a well-articulated energy diplomacy in

Central Asia in terms of strategy, implementation is hindered by a lack of connectivity, bureaucratic inertia and lack of involvement of the private sector. Furthermore, much of the literature available on the subject views energy diplomacy rather through the prism of hydrocarbons and pipeline projects, where, comparatively little attention has been given to the concept of nuclear energy cooperation as a strategic tool.

Therefore, as much as the literature offers useful information on the motivation and challenges of Indian involvement in Central Asia, it still is quite divided and tends to be disintegrated between geopolitics analysis and industry-based energy policies. This paper fills this gap by analyzing nuclear diplomacy, especially Indo-Kazakhstan cooperation, as a very important unexplored aspect of Indian energy outreach in the region.

Theme 3: Indo-Kazakhstan Civil Nuclear Cooperation

This sub section especially addresses the nuclear relation of India with Kazakhstan. Such authors as Singh (2016), Supyaldiyarov (2024), and Tumanshiyev et al. (2024) consider the 2011 civil nuclear agreement, uranium supply commitments, and bilateral energy diplomacy. Even though the agreement is considered to be a milestone, several studies indicate that the implementation was delayed, and there were regulatory hurdles and a lack of growth into technical cooperation.

The Indo-Kazakh nuclear cooperation is an important aspect of India strategic energy policy to diversify its power source by not relying on fossil fuel as it works on strengthening its ties with the Central Asian states. The position of the biggest producer of uranium in the world of Kazakhstan is critical to India as it has not only non-renewable sources of uranium but also increasing electricity demands. The overall conclusion of this literature is that nuclear cooperation is not merely a transactional one, but indeed, it is entrenched in long-term objectives of energy security and foreign policy of India.

Singh (2016) presents a background discussion on the civil nuclear deal in 2011 between India and Kazakhstan. This accord includes the undertaking of Kazakhstan to provide uranium to India thereby, to keep the operations of India Pressurized Heavy Water Reactors (PHWRs) in operation. Tumanshiyev et al. (2024) go even further to put the cooperation within the broader context of Eurasian geopolitics, and focus on the role of nuclear cooperation as a source of bilateral strategic alignment. Similarly, Supyaldiyarov (2024) emphasizes on the two-sided character of Kazakhstan as both a dependable supplier

of uranium and a diplomatic partner assisting India to balance conflicting regional powers.

Earlier sources such as Umarov (2009) and Chaudhury (2009) provide a historical-geopolitical backdrop, the history of the development of the Indo-Kazakh relations, and the initial opportunities of nuclear cooperation since the independence of Kazakhstan. These articles emphasize the importance of the multi-vector foreign policy of Kazakhstan to be in a position of engaging with other rising powers, including India, without necessarily being strategically neutral. The importance of the cultural, institutional, and multilateral ties in enhancing nuclear cooperation that is not related to the exchange of resources is also highlighted by Sajjanhar (2009) and Kumar and Aggarwal (2020).

Subsequent scholarship has examined the operational and institutional dimensions of this partnership. Mondal (2023) attributes the consistent supply of uranium by Kazakhstan to have put India in a position of greater energy security and Pradhan (2022) argues that India is still relying on the response-based energy diplomacy strategy that must be strengthened by institutionalized mechanisms to interact with long-term energy. Mehta (2019) critically assesses the issues of implementation such as hold-ups in customs, inefficiencies in finances, and poor project monitoring systems. Rathi and Bansal (2020) introduce a socio-institutional level, mentioning that the awareness of nuclear cooperation among academic and popular stakeholders is low, which reduces the opportunities of collaboration on a larger scale.

More current research has added even more layers to the analysis by adding the global dynamics of the uranium market and the changing geopolitical competition. In her article, Sulaimanova (2023) explores the shift of Kazakhstan towards low-carbon energy options and how its nuclear industry fits in the world sustainability agenda and makes it more appealing as a strategic partner. Zhumadilova (2021) examines the nuclear diplomacy of Kazakhstan, as it tends to make long-term agreements, which can guarantee stability and diversification of the economy. The growing role of Kazakhstan in world uranium supply chains is also emerging as an additional factor (especially in the context of the growing nuclear energy demand and market instability) (World Nuclear Association, 2024; Kazatomprom, 2024). Furthermore, recent policy changes have shown that there is renewed interest in strengthening the uranium supply agreements between India and Kazakhstan, which demonstrates the role of the latter in the nuclear energy policy of India (Economic Times, 2024).

Although these contributions exist, limitations are noted in the literature. Much of the available literature deals with the agreement as a diplomatic breakthrough or supply deal, but comparatively little is known about its strategic consequences in the long-term, technological cooperation and how it can be incorporated into the domestic nuclear growth ambitions of India. Moreover, the critical analysis of the influence of structural asymmetries, logistical challenges, and competition of the largest powers like China and Russia on this cooperation is lacking.

Therefore, although the literature is aware that the Indo-Kazakh nuclear cooperation has been an important breakthrough in the Indian energy diplomacy, it is analytically incongruent and tends to be descriptive in character. This paper is an extension of previous research that creates a more cohesive understanding of nuclear cooperation as it relates to larger geopolitical processes, infrastructural limitations and theoretical perspectives of energy security and strategic interdependence.

Theme 4: Competing Regional Powers: China, Russia, and the United States

This section reviews literature on the geopolitical competition in Central Asia, particularly China's BRI influence and Russia's legacy networks. The limited connectivity and underinvestment of India restrict its position as the authors such as Patnaik (2010), Chong (2010), and Cohen (2006) demonstrate. The literature promotes multilateralism and multilateral cooperation and infrastructure to neutralize regional forces.

Central Asian energy politics has taken on a new dimension with various layers of competition among China, Russia, and the United States being the world powers. The region has gained a great strategic value after the dissolution of the Soviet Union because of the huge deposits of oil, gas and uranium. The current literature widely supports the fact that Central Asia has become a disputed geopolitical arena in which energy resources, infrastructural and strategic alliances overlap to influence both the foreign policies of the regional and external actors.

Through comparative analysis of India and China in their engagement with Central Asia, Patnaik (2010) shows that China was the first to engage and had to be proactive in its engagement with the region by the use of confidence-building mechanisms and institutions like the Shanghai Cooperation Organisation (SCO). Mahalingham (2004) continues to point out that the geographical closeness of China has helped it to forge massive energy

partnerships, especially with Kazakhstan, and thus gain long-term access to oil, gas and uranium resources. Chong (2010) introduces a domestic aspect to the strategy of China by connecting the external source of energy to domestic environmental issues and the necessity to diversify energy systems that are coal-based. Taken together, these works highlight how China can combine economic, environmental, and geopolitical goals into an integrated energy strategy.

The involvement of Russia in Central Asia is considered in terms of history and institutional. As Joshi (2000) points out, Russia has remained influential due to geopolitical, economic, and cultural relations that Russia had as a result of the Soviet era. Cohen (2006) shows how the pipeline infrastructure in Russia gives it a lot of leverage in terms of controlling the flow of energy and the mechanism of pricing. The regional institutions, such as the CSTO and the Eurasian Economic Union, also reinforce the structural benefit as they unite the Russian presence in the region. These tests suggest that the strength of the Russian power does not exist in the domination of resources only but also institutional and infrastructural domination.

Authors like Pant (2004) and Khosla (2010) discuss the role of the United States and the Western powers in that they have a strategic interest in continuing to control the energy corridors of Central Asia. Their interaction is typically spoken about in terms of geopolitical alignment, institutional redesign, and enabling alternative energy directions, which reduce the dependency on the Russian and Chinese systems. Their participation, however, is relatively less systematic and more selective and is oriented to larger strategic and ideological aims instead of long-term integration of infrastructure.

Ahmed (2009) also offers a critical view that India has been a relatively reactive and less coordinated approach to energy diplomacy in Central Asia, but in comparison with China and Russia. Grare (2000) also adds an institutional layer by noting the presence of multilateral bodies of organizations like the SCO, CSTO, as arenas of negotiation between smaller Central Asian states and major powers. All these studies point to the fact that low connectivity, low levels of investment and slow pace of policy implementation are some of the factors that have limited the capability of India to compete effectively in the region.

More recent research has also enhanced the insights on geopolitical rivalry in Central Asia. Recent commentaries note the increasing role of the Belt and Road Initiative (BRI) by China, which has greatly increased its infrastructural and economic presence in the region,

especially in the energy sector of Kazakhstan (Ersin, 2024). Simultaneously, Russia is still able to keep up strategic advantage due to its dominance of energy transit routes and security partnerships, despite adjusting to the evolving global situation in the wake of the Russia-Ukraine conflict (FPRI, 2024). New literature also points to the multi-vector foreign policy of Kazakhstan that enables the country to juggle its ties with China, Russia, and Western countries and diversify its economic relations (Lansing Institute, 2024).

In this transforming world Central Asia is no longer merely a land of resources, but of chameleonic geopolitical space, of competing interests and infrastructural investments, of alliances. However, most of the literature that exists is aimed at the consideration of these powers in isolation or in contrast to each other on a bilateral basis, but little is done to consider the relationships of these powers with each other and their net effect on the energy order in the region.

Therefore, although the literature offers a detailed account of great-power competition in Central Asia, it is rather fragmented and does not have much integration with the energy and nuclear diplomacy policies of India in particular. This paper will fill this gap by looking at the direct impact of geopolitical rivalry especially in the uranium industry in Kazakhstan on the energy security, strategic planning and policy decisions of India in the wider context of the Eurasian region.

1.10 Synthesis of Literature

The review of literature presented above highlights that India's energy security discourse has evolved across multiple dimensions, including economic vulnerability, strategic diplomacy, and geopolitical competition. The body of scholarship, in aggregate, affirms that the energy problems facing India are structural in nature (dependent on imports), inefficient infrastructures, and more and more exposed to the shocks of the global market. The need to diversify the energy sources and to reinforce the domestic energy systems is a consistent theme in studies by Singh (2010), Pant (2007), and Chakraborty et al. (2021).

Meanwhile, the literature about energy diplomacy of India in Central Asia (Ahmed, 2009; Bisaria, 2013; Dash, 2013) reveals the slowly evolving trend of a regionally restrictive approach to a more strategic and policy-oriented participation. These literatures

indicate that Central Asia has also become an important alternative energy frontier, especially with the issue of decreasing reliance on West Asia. They however, also note the ongoing issues of connectivity, infrastructure and execution of policies, which still limit effective participation of India in the region.

This discourse is also given an important dimension by the scholarship of Indo-Kazakhstan nuclear cooperation. According to Singh (2016), Supyaldiyarov (2024) and Tumanshiyev et al. (2024), the 2011 civil nuclear agreement was a high point in the energy diplomacy of India. The literature highlights how Kazakhstan has been a dependable supply of uranium and a strategic ally in underpinning the nuclear energy objectives of India. The growing role of Kazakhstan in the world uranium supply chain is also emphasized in more recent works (World Nuclear Association, 2024; Kazatomprom, 2024) especially within the framework of the growing nuclear energy demand and energy transition objectives (National Atomic Company Kazatomprom, 2025).

At the same time, the references to the geopolitical competition (Patnaik, 2010; Chong, 2010; Cohen, 2006) show that the Central Asia is not only a land of energy resources but a strategic territory that is under the influence of the rival interests of China, Russia and the United States (Foreign Policy Research Institute, 2024). The modern-day literature (Ersi, 2024; FPRI, 2024) also indicates that the Belt and Road Initiative of China and the institutional influence of Russia still prevail in the region and thus restrict the maneuverability of India and its strategies (Pan, 2024).

In spite of these useful inputs, the literature is still analytically divided into economic, geopolitical and sectoral aspects. The integration of energy vulnerability and energy diplomacy studies and nuclear cooperation is limited. Specifically, the use of nuclear diplomacy, as a strategic tool to enhance the relationship between domestic energy demands and foreign interactions of India has not been adequately discussed in an in-depth and holistic approach.

Moreover, although a number of works recognize the presence of Indian involvement in Central Asia, a comparatively smaller number of works examine the aspects of operational and implementation of Indo-Kazakhstan nuclear co-operation more critically, particularly regarding the logistic, institutional co-ordination and long-term strategic consequences. The relationship between theoretical concepts - securitization, structural power and interdependence and empirical data also has not been fully explored.

Therefore, the existing literature is a great source of background knowledge on energy issues in India and its foreign relations, but without a comprehensive theoretical framework that bridges the three areas of vulnerability to energy, nuclear diplomacy, and geopolitical rivalry in one consistent work. This calls on the need to further explore Indo-Kazakhstan nuclear cooperation as a strategic response to India energy insecurity.

1.11 Research Gap

The review of literature demonstrates that considerable scholarship exists on India's energy vulnerability, energy diplomacy, Central Asian geopolitics and the country's nuclear-energy transition. However, these dimensions have frequently been examined separately. Studies of India's energy security have concentrated largely on import dependence, fossil-fuel vulnerability and domestic energy requirements, while scholarship on Central Asia has generally focused on hydrocarbons, connectivity and great-power competition. Similarly, studies of India–Kazakhstan relations have acknowledged the importance of uranium cooperation but have often treated the relationship primarily as a diplomatic or commercial arrangement.

The present study addresses this fragmentation by integrating energy security, nuclear diplomacy, geopolitical competition, structural power, connectivity and bilateral institutional cooperation within a single analytical framework. Particular attention is given to the distinction between contractual access to uranium and structural participation in the nuclear supply chain. The study therefore moves beyond the question of whether Kazakhstan supplies uranium to India and instead examines the conditions under which such cooperation can remain strategically sustainable. This approach enables the research to assess India's current position relative to China, Russia and other external actors and to identify possible pathways for transforming a predominantly transactional relationship into a multidimensional strategic partnership.

1.12 Research Methodology

This study takes a qualitative-historical-analytical stance in its investigation of the nuclear energy policy in India with reference to its strategic interest in engaging with Kazakhstan and the wider Central Asia. The character of the research-centered on bilateral

treaties, geopolitical strategy, and the frameworks of policies-requires an approach based on an interpretive analysis as opposed to numerical modeling.

In order to improve the rigor of the analytical component of the work, the approach of Critical Content Analysis is also adopted in the study, according to which policy papers, agreements, and discourses of the institutions can be systematically analyzed. It is the best method of the interpretation of the underlying assumptions, the strategic intent and power relations behind the official texts and academic discourse.

Qualitative and Historical-Analytical Approach

The study is aimed to track the history of development of the Indo-Kazakhstan civil nuclear cooperation and evaluate the strategic and operational consequences of the same. The historical-analytical approach will enable the research to examine institutional choices, diplomatic achievements, and policy shifts throughout a certain period between 1991 (post-Soviet independence, and liberalization of India) and 2025. The approach offers a rich contextual insight into the political, economic, and logistical dynamics that inform the energy diplomacy of India.

Meanwhile, the Critical Content Analysis incorporated adds value to this method, allowing interpretation of textual data in a deeper way. The paper critically examines as well the construction and representation of energy security, nuclear cooperation and geopolitical positioning in the official discourse of policy documents and agreements rather than perceiving it as a neutral source.

Primary Data Sources

- The 2011 India–Kazakhstan Civil Nuclear Cooperation Agreement, Joint declarations from bilateral summits (2009, 2015, 2017, 2023)
- Official documents and press releases from India's Ministry of External Affairs and Kazakhstan's Ministry of Energy
- Reports and compliance records from the International Atomic Energy Agency (IAEA).
- Expert perspectives from 12 key respondents (Data collected via in-depth interview schedule using purposive sampling technique).

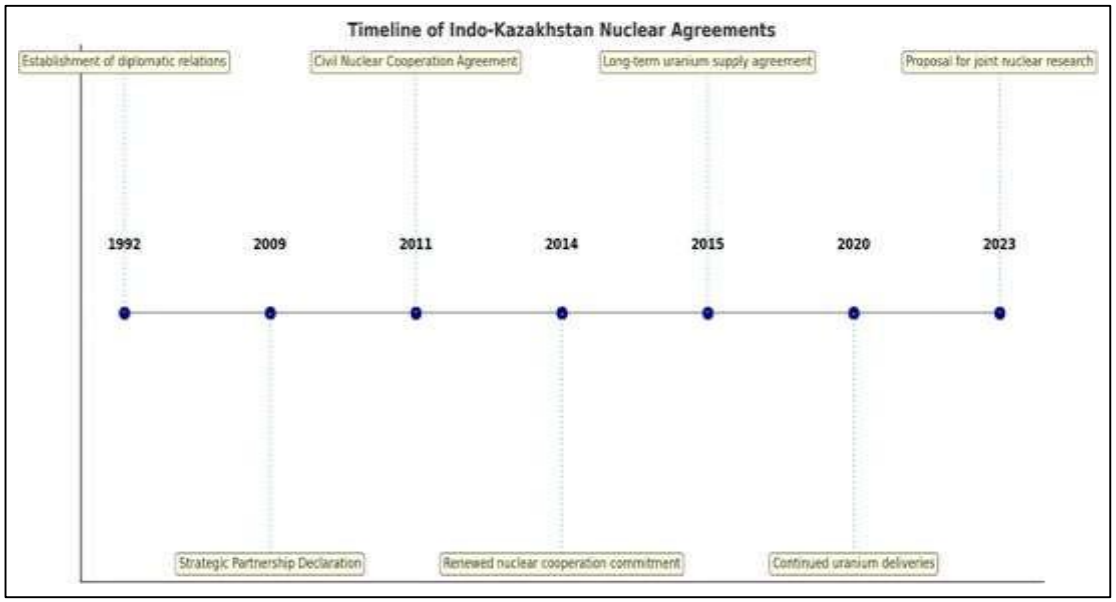
Secondary Data Sources

- Peer-reviewed academic works (e.g., Singh, 2016; Supyaldiyarov, 2024)
- Think-tank publications from IDSA, ORF, Brookings India
- Government white papers and strategic policy briefs
- Scholarly articles and books on nuclear diplomacy and Eurasian energy politics

Critical Content Analysis and Thematic Framework

The data are arranged on thematic basis under the following themes: policy evolution, infrastructure bottlenecks, regional influence and regulatory frameworks. A comparative analysis is used to compare the nuclear diplomacy of India with other key players- especially China and Russia- in Central Asia.

Figure 1.2: Strategic Timeline of Indo-Kazakhstan Nuclear Cooperation (1992–2023)



Illustrates key milestones in diplomatic and energy cooperation between India and Kazakhstan, including civil nuclear agreements, uranium deliveries, and policy shifts.

The study uses Critical Content Analysis as a main analysis tool to thoroughly analyze textual materials, including:

1. The 2011 India–Kazakhstan Civil Nuclear Cooperation Agreement
2. Joint declarations from bilateral summits (2009, 2015, 2017, 2023)

3. Official communications from the Ministry of External Affairs (India) and Kazakhstan's Ministry of Energy
4. Reports and compliance frameworks of the International Atomic Energy Agency (IAEA)
5. Academic literature, think tank reports, and policy documents

This way, the research unveils frequent themes, trends, and discursive forms in relation to energy security, nuclear diplomacy, and geopolitics throughout the region. It focuses on how these writings reflect the strategic priorities, institutional constraints, and power dynamics between India and Kazakhstan in a bigger Eurasian context.

The data are organized using thematic coding, with key categories including:

1. Energy vulnerability and supply security
2. Nuclear cooperation and uranium trade
3. Geopolitical competition and regional influence
4. Infrastructure and logistical constraints
5. Institutional and policy frameworks

This thematic method enables the comparative and interpretive analysis, interconnecting textual evidence with more general theories like securitization, structural power and complex interdependence.

Ethical Considerations

In this study, the researcher follows the ethical standards of the academic research as all the references used are credible and openly available. All the references are done in APA style. No classified or secret information will be utilized and no speculative interpretation is done in the study. Consistent with the application of Critical Content Analysis, special attention is paid to the fact that the interpretations of policy documents are based on evidence, but the possibility of institutional bias in official accounts is also considered. In addition, before conducting the in-depth interview with selected 12 key respondents, their consent was taken in consideration.

1.13 Scope and Limitations of the Study

Scope of the Study

The study concerns the policy of nuclear energy in India and the strategic involvement in Central Asia with a more specific case study of Kazakhstan. The time frame is 1991-2025, which includes the years of economic liberalization of India and independence of Kazakhstan, along with the most important events in the field of diplomatic, economic and nuclear policies.

As a geographical focus, the research will focus on India and Kazakhstan, with the inclusion of pertinent comparisons to China and Russia to put energy competition in the region into context. Thematically, it highlights the significance of civil nuclear cooperation, uranium trade, strategic diplomacy, and access to infrastructure.

As part of the adoption of Critical Content Analysis, the paper will mainly analyse policy documents, bilateral agreements, institutional reports and scholarly literature to understand the development and the implication of the Indo-Kazakhstan nuclear cooperation. It does not cover nuclear activities in military or defense aspect and does not talk much about the policy of India on the fossil fuel other than what will be required to understand the context.

Limitations of the Study

Several limitations shape the contours of this research.

First, the research is based on documents that are publicly available, mostly the policy reports, agreements, and institutional publications. These limitations in accessing classified documents, confidential contracts and commercial transactions may limit the scope of knowledge about the working and financial nature of the Indo-Kazakhstan nuclear partnership.

Second, the research is interpretive due to the Critical Content Analysis. As much as in doing so one can be in a better position to understand the policy stories and strategic aim, it may introduce a certain degree of subjectivity to the interpretation. To address this, the study supports analytical rigor through cross-referencing different sources and in coding thematic consistency.

Thirdly, government publications, official releases, and institutional books are many

primary sources that may be biased by institutions and even political parties. These records are likely to be subject to state perceptions and this may not give a whole picture of the underlying strategic constraints or even conflict of interest.

Fourth, to a great extent, the research is based on English-language sources, which may limit the access to original policy discourses and works in Russian or Kazakh. Although translated and secondary sources have been used where feasible, this might affect the comprehensiveness of the analysis.

Fifth, the research is not quantitative modelling or econometric analysis based and therefore there is no predictive or statistical validation of research. Rather, it offers qualitative and analytical elucidation of the policy trends and developments.

Finally, the adaptability of the geopolitical processes, including the changes in alliances, market, and conflicts within the region can influence the generalizability of some of the findings in the long run. This way, the results of the study will be interpreted within the frames of time- and analysis-specificity of the research.

1.14 Chapter Scheme

Considering the magnitude of research objectives and the subject matter, this thesis is structured under six chapters which are contributory to the overall understanding of nuclear energy policy that India has towards Central Asia with a special case study of Kazakhstan. The chapter plan is in the order and theme arrangement as indicated in the synopsis.

Chapter 1: Introduction

This chapter lays down the conceptual background of the study. It describes the energy and nuclear vulnerability of India, offers its nuclear policy to Central Asia, and offers a historical review of Indo-Kazakh nuclear collaboration. It specifies the research goals, queries, tentative assumptions and justification. It also discusses the literature review and describes the methodological framework that was used in the study.

Chapter 2: India's Energy Security Landscape and Central Asian Policy Framework

This chapter examines the energy needs, imports and nuclear aspirations in India. It talks about the wider policy programs of India- including the strategy of the region known as the Connect Central Asia- that is directed at increasing the energy collaboration in the region. The importance of Central Asia to the energy diversification process in India is critically discussed.

Chapter 3: Evolution and Implementation of Indo-Kazakhstan Nuclear Cooperation

This chapter dwells on bilateral civil nuclear agreement that was signed in 2011. It offers both quantitative and qualitative data on the amounts of uranium supplied, conditions of cooperation and diplomatic interactions. There are issues of logistics, regulatory systems, and geopolitical rivalry, which are addressed in depth.

Chapter 4: Geopolitical Dynamics and India's Strategic Options

This chapter compares geopolitical rivalry in Central Asia, especially the role of the Belt and Road Initiative by China and the historic domination of Russia. It discusses the strategic plans of India-International North-South Transport Corridor and Chabahar Port-in response to accessibility constraints. It also finds the opportunities and limitations to the regional energy diplomacy of India.

Chapter 5: Expert Perspectives on India's Nuclear Energy Policy Towards Kazakhstan and Central Asia

This chapter seeks to analyze the expert perspectives of selected key respondents (Total 12) using the in-depth interview schedule. The subject matter of this chapter has been presented under seven themes keeping in view the coherency of research objectives and subject matter thereby.

Chapter 6: Conclusions and Strategic Recommendations

In the last chapter, the author summarizes the results of the study, assesses the efficacy of the existing Indo-Kazakh nuclear cooperation and provides recommendations of actions to be taken. These comprise institutional, infrastructural, and policy-based initiatives in order to maximize the Indian nuclear policy and enhance its geopolitical presence in Central Asia.

CHAPTER 2

INDIA'S ENERGY SECURITY LANDSCAPE AND CENTRAL ASIAN POLICY FRAMEWORK

2.1 Introduction

The energy security in India has changed not only the sectoral policy focus but also the strategic imperative. As the country continues to experience economic growth, increased urbanization and geopolitical ambitions during the post-liberalization period, energy ceases to be considered in the context of resource sufficiency but on the platforms of sustainability, sovereignty, and resilience. Energy security is the continuous access to energy at a reasonable cost. It has four main dimensions which include availability, accessibility, affordability and acceptability. In the case of India, energy security is not only about avoiding power cuts or shortages of imports; it is also related to the sovereignty of development, economic development, and security of the nation. With the increase in the reliance of imports on oil (more than 85%), gas and uranium, the capability of establishing consistent and diversified energy relations becomes crucial in maintaining strategic independence.

India has undergone an energy consumption structure that has never been seen before, triggered by the economic reforms that started in 1991. The process of liberalization led to the development of the industry, the expansion of infrastructure, and the spread of electricity to households, all of which caused a boom in hydrocarbon dependence. The energy elasticity of India is still high compared to the international standards, which shows the extent to which economic performance is linked to energy consumption (Srivastav, 2020). Aggressive renewable energy targets notwithstanding, fossil fuels still hold sway with coal still contributing the largest percentage in electricity production. The Indian energy policy of 2023 keeps coal as a baseload resource important and tries to increase solar and wind energy (Raizada *et al*., 2024). In the meantime, the remaining derisking gaps in the financing of off-grid renewable solutions, such as mini-grids, are identified as a barrier to electrification in rural and under-served areas (Malhotra *et al*., 2017).

The fragilities of the Indian energy system do not pertain only to the supply-side scarcity; it has to do with the resilience to climate and economic pressures. The Chennai

floods caused huge energy access shocks owing to price and income shocks especially to the urban poor population, and this phenomenon highlights the vulnerability of consumption during the occurrence of disasters (Agarwal *et al*., 2024). On the national scale, the increase in demand peaks and the decarbonization drive make the electricity grid operation more challenging. The management of demand volatility and granularity is identified as one of the key challenges in the 2030 electricity system of India as it increases the use of intermittent renewable sources (Tongia, 2022). Energy storage forms critical infrastructure to stabilize the grid against instability and provide dispatch flexibility in a high-renewables future (Barbar *et al*., 2023). In parallel, the retrofitting of coal plants is discussed as an interim measure to maintain grid stability in the transition to net-zero goals (Ding *et al*., 2025).

Yet, these technical and infrastructural challenges are compounded by gaps in governance. One of the long-term failures in the energy transition in India is institutional capacity-the capacity of public institutions to design, implement and enforce energy policy. The overlapping jurisdictions between ministries (e.g., Power, New and Renewable Energy, Coal) and the inertia in regulatory bodies (state electricity boards (SEBs)) are the obstacles to the scaling of the energy efficiency programs and the inability to coordinate the action (Malhotra et al., 2022). The disjointed governance structure hinders the systemic planning and constrains the resilience-building at national and subnational levels.

The issue of energy in India has been securitized, a concept taken by the Barry Buzan theory in which a problem is constructed as an existential threat that needs extraordinary policies to deal with it. This has justified the reasons to treat energy procurement and diversification as issues of national defense rather than simply developmental issues. The International Political Economy (IPE) lens, especially in the theorization of Susan Strange, can be used to explain the structural weaknesses of India in the global energy system, *i.e.* its inability to control supply chains, prices, and technology makes it extremely vulnerable to international turbulences. The attempt by India to re-balance these asymmetries via external relationships is therefore not merely economic, but highly political.

India, in its turn, has adjusted its foreign energy policy to incorporate new and stable partners. Its Central Asian expansion is a paradigm shift in its dependence on unpredictable suppliers in the Gulf to a diversified energy policy. This can be observed

especially in uranium trade agreements with Kazakhstan, natural gas partnership in TAPI and solar technology partnership with Uzbekistan. These actions are not in itself stop-gap but are part of a broader gambit of reducing the demand-supply asymmetry, a structural imbalance between the rising energy demands and the unavailability of domestic capacity to supply them, to improve the global bargaining power of Indias. Thus, it has the dual effect of both critically investigating the internal India energy vulnerabilities, such as infrastructure bottlenecks, fossil fuel lock-ins, and regulatory fragmentation and analyzing the geopolitical logic of India reaching out to Central Asia as a strategic reaction to its internal energy vulnerability and external dependence. The Indian dream of becoming a major power can no longer exist without the sovereignty in energy (Paul, 2024). Moreover, sustainable energy transitions are not only domestic policy objectives but global priorities in the warming world with profound geopolitical implications (Dubash, 2019). The incorporation of development and climate priorities is not a choice-it is the basis of plausible energy diplomacy.

2.2 The Political Economy of Energy in Post-Liberalized India

The energy scenario in India has witnessed a sea change since the economic liberalization started in the year 1991. A new political economy of energy was signified by the replacement of a Nehruvian paradigm of self-sufficient socialist planning with a market-based model of energy governance. Political economy in this context is the emerging interaction between economic liberalization, political interests, institutional frameworks and international contingencies in the production of energy policies and their execution. The monopoly of the state as a provider of energy was replaced by the hybrid form of governance, where the preponderance of the public sector existence is complemented by the growing involvement of the private, as well as the foreign sector (Ghosh, 2023; Chatterjee, 2017).

The liberalization of energy sector to foreign direct investment (FDI) was among the common transformations that occurred in the post-liberalized India. This policy shift enabled foreign participation in areas that were quite necessary such as generation plants of renewable energy sources, oil exploration and power transmission. It facilitated diversification of the energy and prevented overdependence on coal, triggering the transfer of technology, as it is revealed by (Irfan and Ojha, 2023). The very fact that India has set

climate targets in the Paris climate agreement and the Glasgow Climate Pact also stimulated this process, and especially the renewable energy sector (Singh *et al*., 2023). It was this reorientation towards energy liberalization, understood as the deregulation and privatization of energy markets, which placed India in the position of an emerging global actor in the green energy transition.

Nevertheless, the process of liberalization has not been homogenous throughout the country. Some states in India are much abler to support innovation and investment and make energy transitions than others (Goyal, 2020). By way of example, Gujarat and Tamil Nadu have led the way in adopting renewable sources, whereas the other states are trapped in old systems. Such imbalance is indicative of the profound path dependency of Indian energy institutions - in which the past choices of policy, institutional inertia and infrastructure lock-in constrain the capacity to shift towards new modes of governance (Kathuria and Natarajan, 2022).

One of the significant spheres of tension in the Indian energy political economy is the politics of subsidy system. Subsidy politics Subsidy politics is the practice of using state subsidies (particularly those on coal, kerosene, LPG and electricity) as a form of political patronage, social redistribution and election strategy. These subsidies, although initially meant to help in mitigating energy poverty, have in most cases ended up being economically distortive and regressive. These subsidies often end up enriching the already rich households at the expense of the poor, not mentioning that they discourage investment in clean energy (Sovacool, 2017; Inchauste and Victor, 2017). Nevertheless, subsidy reform, even though programs such as PAHAL and Direct Benefit Transfers (DBT), continues to be both institutionally and politically difficult (Rentschler and Bazilian, 2017; Raizada *et al.,* 2024).

Such complicated processes can be well analyzed through the theory of structural power by Susan Strange. Structural power is the capacity of states or institutions to define the frames within which others have to act- the markets, financial movements, security arrangements and the knowledge systems (May, 1996). Following the case of India, the state has maintained its formal control over energy policymaking, but the underlying energies of energy production and distribution are getting progressively affected by global commodity markets, multinational companies, and international climate regimes. Being a net importer of oil and natural gas, the energy sovereignty of India is susceptible to external price

shocks and disruptions of the supply chain (Chatterjee, 2024). At the same time, the dependence on imported technology and capital in the renewables is a manifestation of the external dependency in a new guise, if not in more environmentally friendly colors.

The global political economy of energy, particularly, the volatility of international oil markets also contributes to making India vulnerable. India received an impetus to start its journey to energy self-sufficiency due to the energy crises of the 1970s (Chatterjee, 2024). But after the liberalization, the reliance on foreign hydrocarbons rose drastically, with countries of the Middle East being key suppliers. The geopolitical risks of such dependencies were painfully obvious in the case of the global financial crisis of 2008 and the Russia-Ukraine conflict that has also disrupted the supply chain and caused inflationary pressures. The present policy of Indian is attempting to fill this in through diversification, strategic reserves, and more regional cooperation-however, they still have structural weaknesses. Moreover, economic growth and energy access are intersected, bringing additional complexity. Despite large-scale rural electrification efforts, there are still energy access and affordability disparities in how people live, particularly marginalized populations (Rao and Pachauri, 2017). This discrepancy between access and usage underscores the limitations of supply-side reforms to meet wider development goals.

Finally, and not the least, the state role in energy transition guidance is two-sided. Despite the rhetoric acceptance of sustainability by successive governments, institutional capacity remains dispersed and the reforms are rather patchy. This is presented as a paradox of political economy-the state welcomes liberalization but at the same time maintains a centralized role in pricing, regulation, and cross-subsidization (Ghosh, 2023). It is in this sense that the energy transition in India after liberalization is not a success story or a failure, but a struggle with its share of contradictions, trade-offs, and shifting power equations. Though the political economy of energy transition in India has been influenced by the politics of liberalization, subsidies, and structural powers, these institutional changes need to be examined along with the material pressures that are coming up within the domestic arena. The increasing energy demand-supply gap especially amidst rapid urbanization, industrialization and population explosion has further increased the imperativeness of readjusting the Indian energy mix. Thus, the changing domestic energy consumption structure, demands of various sectors, and technological limitations require more careful consideration so that the rationale of diversification policies, especially the

growing use of renewables, natural gas, and nuclear energy could be comprehended.

2.3 Mapping India's Energy Demand-Supply Framework

The energy scenario in India has changed significantly after the post liberalization period due to the structural limitations, consumption structure of the various sectors and the changing technological paradigms. Once being around 5.8 exajoules in the early 1990s, the national energy consumption has been growing in tandem with the industrialization, urbanization, and the expansion of the middle class with a consumption-oriented culture (Barbar *et al*., 2021; Hunt and Bloomfield, 2025). Behind this sudden rise in demand is a more fundamental weakness that lies in the rigidity on the supply-side and uneven institutional changes.

In terms of sector, the industrial sector has been the highest consumer of energy as it constitutes more than 40 percent of commercial energy consumption in India. Its main drivers of growth are its core industries such as steel, cement, and chemicals which are energy-intensive in nature and mostly depend on coal. The residential sector presents however a paradox of greater electrification and energy poverty. Millions of homes are still unproductive with their appliances, inefficient, and they pay high unit charges of energy since they lack the proper insulation, infrastructure, and normal power supply even with the improved grid penetration (Gupta et al., 2025). The fact that energy poverty is sharp in rural regions and peri-urban areas also contributes to the spread of spatial inequality.

Another complexity is the energy use in farming. Despite such programs as solar pump programs, subsidized power schemes, and other measures, the industry is still very reliant on diesel, especially used in irrigation during the high cropping seasons. The trends increase the environmental expenses and national oil importation liabilities. The transport industry, too, has been characterized by only slight shifts to electrification. The vehicle fleet in India is still mainly fueled by petroleum products, which constitute a big portion of the imports bill in India. Although policies may encourage the adoption of electric mobility, bottlenecks in infrastructure, behavioral resistance, and insufficient charging ecosystems hinder mass adoption.

India's energy mix is emblematic of long-standing path dependencies (Long et al., 2025). Coal is still in the ascendant providing over 70 percent of electricity, a fact that is a

result of domestic resources, well-established industry and a kind of inertia in the infrastructure. The decision to shift towards the gradual reduction of coal instead of eliminating it, as recommended in international conferences, is indicative of how India prudently manages to weigh between environmental concerns and economic and employment issues (Pandey and Kumar, 2025). Although renewable energy has scored big points-particularly solar and wind-they are intermittent and that is a major issue when it comes to integration with the grid, especially in states with inefficient transmission systems (Sobha, 2022; Tongia, 2022).

Policies and technological solutions to such challenges are yet to be developed (Luhaniwal et al., 2025). Smart grid technologies and energy storage systems are billed as key answers to peak demand and fluctuating supply. Nevertheless, the grid structure and regulatory environment in India are not as prepared to accommodate high renewable penetration (Barbar et al., 2023). Interventions such as coal plant retrofitting, although good on paper, are confined to certain industrial corridors and lack funding and implementation gaps (Ding *et al.*, 2025).

Comparisons with other countries also show the structural inefficiencies in India. The energy intensity-energy use per unit of GDP- in India is still much greater than that in China as well as in the OECD countries (Ji and Sotnyk, 2023). This implies that there are systemic inefficiencies in energy consumption not just at the production stage but also in transportation, distribution and consumption. Equally important is the fact that the contribution of nuclear energy is less than 2 percent in electricity generation. Unlike other countries like France and Russia which have been harnessing nuclear energy to reduce their dependency on fossil fuels, the nuclear potential in India has been underestimated because of regulatory hurdles, capitalization, geopolitical aspects. The state-level differences are also characteristic of the national energy story. Some progressive states like Tamil Nadu and Gujarat are incorporating renewable sources, other states are lagging behind as they are reliant on centrally distributed coal or hydroelectric resources. The asymmetry of performance results in difficulty in policy implementation and the need to have a stronger system of federal coordination and energy governance reforms (Hunt and Bloomfield, 2025).

In the meantime, the emergent trends, including more space cooling demand, which is projected to contribute to almost 30 percent of new electricity demand by 2030, and data-

enabled appliances add to the pressure on the energy system (Barbar *et al*., 2021). These complex demand patterns require powerful modeling tools in order to forecast them. The parametric models provide insightful information on demand forecasting on a time-specific basis and infrastructure investment planning (Tongia, 2022). However, the tools have not been fully exploited because of data constraints, as well as poor institutional capabilities particularly in the subnational units. Overall, the energy demand-supply structure of India is being limited by sectoral imbalances, infrastructural disparities, excessive reliance on coal, and regional disparities. There are policy innovations in progress, though the implementation is still scattered and compromised by conflicting ideals of equity, growth and sustainability. It is these domestic imperatives that have forced India to turn outward - to adjust its energy diplomacy and seek external relations that would help insulate against domestic weakness. The second section will explore energy infrastructure and grid resilience in India and chart the extent to which domestic limitations are driving Indian interaction with Central Asia and the rest.

2.4 Strategic Dimensions of Energy Security

The energy security paradigm in India has undergone significant transformation in the country, beyond the traditional and limited focus on the physical availability of energy resources, to a multidimensional focus that encompasses affordability, reliability, sustainability and strategic autonomy. The Indian economic context after liberalization coupled with the accelerating globalization, changing climate imperative, and international power asymmetry has demanded a greater insight of energy as not only a developmental input but a national resource that shapes economic sovereignty, social wellbeing and international relations (Bardhan *et al*., 2019). In India, energy security considerations today encompass the protection of stable energy supplies, minimization of vulnerability to price fluctuations, control of environmental effects and access to technology in both the traditional and renewable energy fields.

This broadened definition of energy security is particularly acute considering the frequent external interferences that have always affected the energy supply lines of India. The changes in international oil prices, observed during the financial crisis of 2008 and, recently, during the COVID-19 outbreak and the Ukraine conflict, have highlighted the vulnerability of the economies that rely on energy import. India has also been vulnerable due

to disruptions in maritime trade in strategic chokepoints such as the Strait of Hormuz. The geopolitical upheaval and risk in the supply chain are a simultaneous influence on the short-term stability of prices and the long-term approach to investment (Khan, 2025). As over 80 percent of crude oil is imported, India is among the heavily vulnerable to such externalities, leading to macroeconomic imbalance by way of inflation, depreciation of currency and fiscal strain. Such economic impacts further trigger down to the societal level, exerting pressure on energy subsidies and widening the energy poverty gap among the vulnerable groups (Raj and Sharma, 2024).

To conceptually grasp this energy priority in national security, the notion of energy securitization has been used with growing frequency by scholars. This theory was developed within the framework of the Copenhagen School and it is used to conceptualize the way political actors can frame issues related to energy as existential threats that need extraordinary political and policy measures. In India, securitization of energy came to the fore with the 1991 Gulf War and the global oil shocks in the early 2000s. These developments triggered a change in policy to hydrocarbon diplomacy, energy import diversification and greater institutional focus on energy strategy. One may witness this institutionalization of the energy security discourse in the establishment of ministries dealing specifically with energy security such as the Ministry of New and Renewable Energy (MNRE) and inter-ministerial energy coordination committees. This construction of energy as a security need enables states to marshal energy and pursue policies that do not, necessarily, follow an economic rationale, including diplomatic, military, and intelligence dimensions (Zohuri, 2023).

This strategic realignment is found in policy documents. The 2006 Integrated Energy Policy was a path breaking attempt to bring together disparate energy policies into a single strategic framework that stressed on economic growth and ecological sensitivity. Not only did the study fail to appreciate the fact that the country relies on fossil fuels, but it further made a mandate to increase the role of nuclear, solar and wind power. The draft of National Energy Policy (NEP) has expanded on the same by promoting the digitization of the grid systems, increased privatization and setting of timeframe objectives to the minimization of emission. Meanwhile, the Nuclear Roadmap 2047 gives a long road map of the atomic power ambitions of India, which takes into consideration the promise of this nation in the Paris accord of reducing the intensity of emissions and attaining 40 percent of

the installed electric capacity using non-fossil fuel by 2030 (Singh *et al*., 2023).

Indian energy security situation is not complete without the geopolitical context. The energy diplomacy has emerged as one of the primary vehicles of foreign policy in India due to the prevalence of the strategic necessity to have stable and diversified sources of energy supply. This geopolitical shift is manifested in the bilateral relations with resource-based countries, the long-term LNG contracts, involvement in regional energy dialogue, including the International Solar Alliance, and the investments in oil blocks in foreign countries (Pardesi and Ganguly, 2020). These international relations may help insure against market uncertainties, provide political goodwill and provide Indian firms with strategic resources abroad. Also, geopolitics of energy is not limited to oil and gas and now spreads to rare earth, battery technologies and nuclear fuel supply chains.

Energy geopolitics has also become the game of influences at regional level especially in South Asia and Central Asia. The degree at which the energy resources and infrastructure are capitalized in the power relations at the regional level-as well as the competition of each country to have the pipeline routes, energy corridors, and inter-country trade agreements-is shown by (Siddiky, 2021). Increased participation in these forums such as the Shanghai Cooperation Organisation (SCO) and in Central Asian republics demonstrates that India recognises the energy as the realm of regional policy.

Nevertheless, despite the progressive reforms, institutional and operational problems still persist in the pursuit of energy security in India. The fragmentation of regulatory jurisdiction, lack of coordination at the center-state, bureaucracy and fiscal strain are all working against the smooth sailing of the implementation of national energy strategies. In addition to this, conflicting interests of economic growth, environmental management and social justice are normally hard to integrate into the same policy agenda, without leading to policy incoherence. These contradictions are expressed in inconsistency of subsidy policy, excessive dependence on coal even in the framework of renewable intentions, and political resistance to rationalization of fuel prices. India is more and more compelled to seek more diversified and reliable partners to its long-term energy policy, both in the framework of these domestic and foreign complications. Central Asia is a crucial component of the extended Indian energy neighborhood, with massive hydrocarbon deposits and an ever-growing geopolitical importance. The local power infrastructure and the preparedness of India to offer long term Partnerships. It will also examine grid

modernization, interconnectivity gaps and last-mile access; some of the key enablers that will determine whether India will be able to absorb and efficiently distribute energy as a by-product of foreign engagements. The internal strength is now becoming the secret to strategy energy independence as India gets connected with the external supply chains.

2.5 Central Asia as a Strategic Energy Frontier

The post-Cold War geopolitical reorientation of the Central Asian region has put the region at the center of strategic energy frontier-a geographical region with abundant underexploited resources that are of paramount significance to the external powers to diversify energy sources and to avoid the fragile maritime routes. The five republics of Central-Asia-Kazakhstan, Turkmenistan, Uzbekistan, Kyrgyzstan and Tajikistan-are blessed with rich energy sources: huge oil and natural gas reserves in Kazakhstan and Turkmenistan, huge uranium reserves in Uzbekistan and Kazakhstan, and huge hydro-power potentials in Kyrgyzstan and Tajikistan. Previously limited by centralization under the Soviet regime and political disjointure during the post-Soviet era, these assets are becoming central again as the global energy paradigm shifts to diversified, regionalized, partnerships and resource-insured pathways (Laldjebaev *et al.*, 2021; Mehta *et al.*, 2021).

The growing Indian interest in Central Asia is a wider strategic realignment of its energy diplomacy which can be described as the utilization of diplomatic and foreign policy instruments to achieve stable and sustainable availability of the external energy and energy infrastructure. Traditionally the energy policy of India relied largely on the West Asian countries-mainly Saudi Arabia, Iran and Iraq- to supply crude oil and LNG. But the increasing instability in the region, combined with geopolitical uncertainty such as the Strait of Hormuz chokepoint, and Iran sanctions, have become a vulnerability to India. Central Asia, in turn, can become a more stable politically and geographically connected option with the chance to strengthen the energy security-defined as the continuous access to energy in a cost-effective way, including the elements of sustainability, reliability, and absence of dependence on monopolistic suppliers (Kaulgud, 2022; Rao, 2018).

After the break-up of USSR in 1991, India had a paucity of the diplomatic facilities and policy interest to have a meaningful interaction with the newly independent Central Asian republics. Early outreach was also limited by the geographic remoteness and lack of direct transit access. With the growing influence of China due to its Belt and Road

Initiative (BRI) and the ongoing influence of Russia however, India began to take action. The multi-alignment doctrine, or the foreign policy principle of India, which involves interacting with other world powers without being exclusive, is especially relevant here (Pradhan, 2020; Kurian, 2020). Energy diplomacy therefore emerges as a tool whereby India can exercise strategic independence whilst establishing long term regional collaborations.

Kazakhstan is the key to the diversification of nuclear energy in India. Being one of the largest uranium producers in the world-with almost 15% of known global uranium reserves-it is critical in providing India with nuclear fuel security, the assured and constant supply of uranium required to operate the growing nuclear power plants in India. This has been further accelerated after the Indo-U.S. civil nuclear deal as India has also signed formal uranium purchase deals with the Kazakhstan national atomic energy corporation Kazatomprom (Rao, 2018). These resources are important to meet long-term climate ambitions of India and increase its non-fossil fuel energy foundation.

On the other hand, Turkmenistan is a country with enormous potential in terms of natural gas. The Turkmenistan-Afghanistan-Pakistan-India (TAPI) pipeline project is a reflection of the nature of pipeline diplomacy, a subdivision of energy diplomacy aimed at establishing transnational pipeline corridors to ease the flow of energy at the same time as enhancing geopolitical power. Despite the delays and instability in Afghanistan, the TAPI is an expression of the Indian ambition to trade in long term overland energy trade which avoids the risky maritime routes (Huda and Ali, 2017; Pradhan, 2020).

In order to contextualize this regional push in global strategic theory, the book, Grand Chessboard by Zbigniew Brzezinski, assumes that the Eurasia is the epicenter of global power politics and Central Asia is its pivot. At the same time, the Heartland Theory, developed by Halford Mackinder, argues that this control over Central Asia-the so-called heartland-gives a chance to control the whole of the Eurasian continent. Although India is not interested in hegemony, these theories elucidate its increasing investments in Central Asia because it is a way of having strategic depth and protecting its economy against disruptions in the global supply chain.

At the institutional level, India has made a number of steps to make this strategic ambition operational. The fact that it is a member of multilateral organizations like the Shanghai Cooperation Organisation (SCO) and that it has come up with bilateral forums

like the India-Central Asia Dialogue are meant to strengthen its presence in the region. Infrastructure projects such as the Chabahar Port and the International North-South Transport Corridor (INSTC), are oriented towards alleviating the logistical disadvantage of India, namely its geographic inability to access Central Asia via direct land access, by facilitating smooth overland energy trade that avoids Pakistan. Such initiatives are indicative of the need to establish physical and diplomatic infrastructure to entrench long-term energy partnership (Kaulgud, 2022).

However, India has a lot of constraints with regard to achieving its vision. BRI activities in China have had a swift and profound infrastructure footprint in Central Asia, whereas Indian participation is bureaucratically slow and an under-resourced matter. Most Indian companies are finding Central Asia a very risky place to invest and this discourages serious involvement by the private sector. Also, continued instability in Afghanistan and resistance by Pakistan to over land transit routes to the country hinder connectivity. The Indian presence in the region in the form of Special Economic Zones as well as trade corridors is still in its infancy and requires expansion to the level of geopolitical ambitions (Aggarwal, 2024).

However, there are limitations to the same, but Central Asia presents India with a strategic prospect other than energy extraction. Central Asia is a region where the energy diplomacy overlaps with the wider foreign policy agenda, as part of an emerging continental identity of India. These actions, which include acquisition of uranium resources in Kazakhstan, seeking pipeline linkages via Turkmenistan and multilateral involvement, put India in a better position of being credible and reliable in an unstable and disputed energy environment. This automatically causes a further exploration of the home architecture that needs to promote such international aspirations. This paper will critically evaluate the energy infrastructure in India, and especially its technological maturity, policy coherence, and the ability to absorb, distribute, and efficiently integrate energy imports-particularly Central Asian imports. This also involves considering the strength of the grid connectivity, storage systems and regulatory systems in India that will be needed to accommodate a growing and diversified energy portfolio. This kind of analysis on a domestic level is necessary to put into perspective the outward oriented strategy of India in the context of its internal preparedness and institutional capability.

2.6 India's Outreach through Connect Central Asia Policy

The involvement of India with Central Asia took a strategic turn as the official statement of the policy of the connections with Central Asia, named as the Connect Central Asia Policy (CCAP) was issued in 2012. The initiative represented a different shift in the Indian foreign policy towards a systematic shift in bilateral relations into a multidimensional policy. The policy was broad-based, covering political, economic, cultural, and strategic spheres, which was in line with the understanding of the Central Asia changing role in energy geopolitics of the world and regional stability (Singh and Kaur, 2014; Ersin, 2024). The policy of the connection of Central Asia was mainly to expand the institutional and strategic presence of India within the post-soviet republics of Kazakhstan, Kyrgyzstan, Uzbekistan, Turkmenistan and Tajikistan-the so-called Central Asian Republics (CARs). These countries are oil-abundant, natural gas, uranium, and hydroelectric potential, and are centrally placed between Europe and Asia. Their strategic importance to India is not merely in energy diversification but also in over-dependence on the politically unstable West Asia could be minimized. India was trying to achieve her strategic interests through CCAP in energy partnerships, trade and transit routes and overtime civilizational connections.

One of the most effective means of strategic engagement in the policy is the civil nuclear diplomacy. The 2011 civil nuclear deal with Kazakhstan enabled India to purchase 5,000 metric tonnes of uranium to feed its local nuclear power plants. It cemented the status of Kazakhstan as a provider of reliable uranium, which contributes to the nuclear fuel security of India in the post-NSG waiver period (Kaulgud, 2022; Rao, 2018). In this regard, civil nuclear diplomacy depicts how India has attempted a wider scope of utilizing technological collaboration as an avenue to strategic independence. Joint Working Groups (JWGs) have also been another bedrock of the CCAP. These institution-based mechanisms such as energy cooperation, anti-terrorism, trade and education make it possible to continue with dialogue beyond the summits and diplomacy. JWGs can offer a platform of pragmatic collaboration and long-term trust-building actions by enabling negotiations on issues at hand (Bhattacharya, 2021; Kothari, 2020).

India has also successfully exercised the soft power diplomacy, which is a power of influencing the global outcomes by the cultural and non-coercive way. The cultural outreach of India is highlighted by activities like the planned Central Asian University,

ICCR scholarships, Days of Indian Culture in capitals of regional states and joint archaeological missions. Such attempts are not merely aimed at creating a benign image of the region, but also aimed at a countermeasure to the aggressive image of soft power that is being projected by the competitors such as China and Turkey in the region (Pradhan, 2020). Geostrategic connectivity also forms a critical aspect of Indian interest in Central Asia. Geography limits the accessibility of India to the region, especially the absence of common borders and the unfriendliness of Pakistan. Because of this, India has turned to using alternative paths more and more, including the Chabahar Port in Iran and the International North-South Transport Corridor (INSTC). The infrastructure connections are a part of the larger Indian Eurasian policy, which enables it to avoid chokepoints and establish its presence in regional trade and energy distributions (Kalyuzhnova and Holzhacker, 2021).

With such utopian goals, the reality of CCAP implementation has experienced significant hindrances. Most prominent among them is the so-called bureaucratic inertia, which is the institutional reluctance to innovations or prompt performance caused by the rigidity of procedures and the inability of agencies to coordinate with one another. Analysts say that most agreements signed under CCAP are under-implemented because they lack either a strong follow up mechanism, political will or the participation of the private sector. Moreover, issues relating to logistical problems such as unreliability of transit corridors and inadequate financial tools have undermined the complete actualization of Indian aspirations. Therefore, the Connect Central Asia Policy is quite symbolic and diplomatically significant yet not as effective. This steady lack of connection between strategic purpose and execution on operation level informs the need of a policy architecture re-tuned, with superior infrastructural readiness and policy integrity. This would need an overall audit of the Indian domestic energy system, trade logistical system, and the institutional machinery that would enable an easy combination with the Central Asian energy systems. The externalistic foreign policy of India with the externalistic study of its internal capacity to assimilate, regulate, and regulate the flows of incoming energy in the Central Asia is one of the major steps towards the translation of the geopolitical dreams into feasible and sustainable success.

2.7 Logistical and Geopolitical Constraints

All the logistical and geopolitical issues that plague India in its efforts to forge robust energy ties with Central Asia are structurally constrained. Unlike other possible regional power houses such as China or Russia, India does not share a direct border with any of the five Central Asian Republics, complicating physical access as well as strategic continuity. Such geographical isolation has meant that India must depend on third party transit networks to get overland access, which is Iran-Afghanistan-Pakistan axis, a route that has been growing weaker with the evolving political scenario in Afghanistan. The resurrection of the Taliban has not only brought instability to the region but also nightmares of long-term logistics planning, and in that sense, India can barely arrange long-term energy trade or infrastructure dealings through this corridor (Kothari, 2020; Rao, 2018).

To balance these limitations, India expediently invested in the Chabahar Port in Iran. Known to be a geopolitical counterbalance to the Pakistani Gwadar Port, Chabahar has been included in the Indian fantasy to reach Central Asia without necessarily passing through an unfriendly land. However, not much has been done. The Chabahar project has been dented by infrastructure delays, the twists and turns in relation between the United States and Iran, as well as the uncertainties surrounding international sanctions regimes. Consequently, what promised to be a game changer, inasmuch as regional interconnectedness is concerned, is yet to live up to its expectations of integrating energy (Singh and Kaur, 2014). To make the matter worse, there is the sluggish operationalization of the International North-South Transport Corridor (INSTC), a multimodal trade route, which is expected to link India to Central Asia, Russia, and Europe via Iran. The corridor, whilst theoretically feasible and diplomatically supported, has failed to live up to its potential because of the absence of high-level coordination and bureaucratic lethargy in the administrative apparatus of India. The INSTC is more of a dream than a reality without the cohesive inter-ministerial alignment and sufficient investment in multimodal logistics (Kaulgud, 2022).

This is also a complex case that transnational pipeline diplomacy is. The Turkmenistan-Afghanistan-Pakistan-India (TAPI) pipeline has seen minimal actual developments in spite of its successful multilateral endorsements on numerous occasions. The continued unrest in Afghanistan, continued aggression with Pakistan and absence of

financial guarantees have made the project a geopolitical ransom. Although TAPI has a significant potential of meeting the gas needs of India, it remains stuck in a loop of delayed schedules and unaddressed risk management problems (Pradhan, 2020). Legal and regulatory matters on the domestic front also hinder India in making long-term strategic agreements in the energy sector (Mauro, 2024). The Civil Liability Nuclear Damage Act 2010 which does not follow the international standards in that it attributes the liability on the supplier as opposed to the operators has discouraged foreign investments particularly in civil nuclear deals. One of the most resourceful and geopolitically oriented allies, Kazakhstan has shown interest in cooperation, but the liability regime is still one of the major obstacles. Furthermore, the state-controlled energy industry of India, with a lack of flexibility and multi-layer jurisdictions, makes the country less agile in its institutions to react to the rapidly changing opportunities in the region (Kushwaha and Verma, 2021).

Even the energy diplomacy of India, with its rhetoric focus on regional cooperation, has an asymmetry of capabilities, compared with the Belt and Road Initiative of China. The lack of infrastructure outreach, small financial investments, and regulatory complications of India have led to a less convincing diplomatic pitch. This asymmetry in strategy undermines the ability of India to negotiate, and diminishes the efficiency of its Central Asia outreach (Kaulgud, 2022). Overall, these logistical and geopolitical factors have considerably scaled back the speed and intensity of India becoming a part of the energy networks of Central Asia. Despite the good intentions behind the policies and discussions, they have been translated into practical, sustainable systems with varied success. Understanding these systemic constraints, India has been keen on enhancing its bilateral relationship with Kazakhstan-the most stable and energy-rich in the region-as a fulcrum to realign its energy policy in the region.

2.8 Competing Powers in the Region: China, Russia, USA

The Indian interest in expanding the depth of its energy and strategic relations with the Central Asia needs to be perceived within a broader geopolitical stage dominated by China, Russia, with the less significant role of the United States and the European Union. All these powers have vested interests and their own tools of influence that become a structural challenge to the ambitions of India in the region. As India tries to create a secure and diversified energy supply chain, it has to compete with powerhouses which already

have well-established institutional mechanisms, infrastructural footprints, and geopolitical advantages in the region. The Chinese interest in Central Asia has increased manifold under its flagship Belt and Road Initiative (BRI), which has established widespread economic corridors, oil and gas pipelines, fiber-optic networks, rail connections and transport networks that cut across the region. These are not just transactional investments but a long-term project of infrastructural and political integration. China has established itself in all five Central Asian states through bodies such as the Asian Infrastructure Investment Bank (AIIB) and Silk Road Fund as well as through bilateral agreements (Ersi, 2024).

The core of its energy diplomacy has involved its strategic purchase of uranium in Kazakhstan, the world's biggest producer of the mineral, which enables it not only to ensure that its domestic energy security but also to influence the supply dynamics in the region to its advantage (Kurian, 2020.). The long-term energy agreements, as well as the co-investment into the extraction and refinement plants, further cement the influence of China. Russia, in its turn, retains a high residual power, which is based on historical, cultural, and institutional legacies of the Soviet era. The Eurasian Economic Union (EAEU), the Commonwealth of Independent States (CIS), and through various bodies such as the Collective Security Treaty Organization (CSTO) Moscow makes sure that Central Asia does not come out of its strategic circle. The scaffolding of influence, which Russia has established through shared language (Russian as lingua franca), elite education networks, dual citizenship, and connected economic structures is so extensive that India has not been able to replicate it (Rao, 2018). Although India and Russia have cordial bilateral relations even in nuclear collaborations, space and defense, the institutional entrenchment of Russia provides it with a much better regional grip. The presence of the troops and military bases, special trade relations, and dependence on infrastructural support strengthens the position of Russia.

The US and EU have more of a normative and values-based approach towards regional involvement. Their infrequent but focused diplomatic and economic activities focus on the democratic form of governance, human rights, environmental, and institutional reforms. Although their corporeal presence in terms of infrastructure or energy routes is not very significant when compared to China or Russia, their strategic power is in providing a counterbalance in terms of ideology and developmental aspects, and frequently

regimes in Central Asia find it appealing to have more partners outside (Kushwaha and Verma, 2021).

However, their interaction is infrequent and does not have the same operational continuity and geographic proximity as that of the regional strategies of Beijing and Moscow. Projects supported by the US tend to rely on more general geopolitical interests and are opposed by institutional resistance by other rival actors in the region. Conversely, the strategic imprint of India is not very high. India has a poor comparative economic presence irrespective of efforts like the Connect Central Asia Policy (CCAP), high-level summits, educational and cultural diplomacy, and capacity-building programs. It has suffered due to a number of constraints: lack of smooth connectivity to the region due to the geographic dislocation, insufficient institutional capacity to carry out projects, inertia in regulations back home, and overdependence on multilateral platforms such as the Shanghai Cooperation Organization (SCO) where its influence is watered down by the leading positions of China and Russia (Dabhade, 2024). The policy structure of India has usually been reactive as opposed to being anticipatory, which has led to the belief that it is a peripheral actor in the region.

Moreover, even the instruments of Indian engagement-academic scholarships, civil nuclear cooperation deals (especially with Kazakhstan), soft power exports of Bollywood and Ayurveda, and small trade deals-symbolically important, do not always prove adequate to the scale, immediacy, and strategic depth of its rivals. The image of India as an emerging yet not yet decisive actor is strengthened by its slowness in the implementation of projects, the bureaucratic slowness, and the reliance on the logistics of third countries, in particular, through the unstable Iran-Afghanistan route. India has been slow but not transformational in the efforts to utilize Chabahar Port and International North-South Transport Corridor (INSTC) as a substitute.

Geopolitical scenario is then a jumble of rivalrous and cooperative relationships, in which India needs to develop a more powerful, multidimensional strategy. A vision of institutional constraints, geopolitical imbalances that cannot be spared is required. Rather than attempting to imitate the infrastructural power of China or the security blanket of Russia, an Indian strategy of discrete hybrid warfare may be available; a mix of high-technology collaboration, educational engagement, climate and energy dialogue, civil nuclear dialogue, and strategic communication. This would aid India to move regional

complexities more craftily and purposely. The Central Asian powerhouse endowed with resources, the diplomatically neutral, and recently aggressive Republic of Kazakhstan has stood out to be the hub of the redefined Indian engagement model. The evolving bilateralism between India and Kazakhstan is not only a sign of energy pragmatism, but also more broadly of the Indian search to seek reliable relationships in the region within a competitive strategic landscape.

2.9 Nuclear Energy Strategy and Kazakhstan's Role

In India, the energy policy has increasingly recognised the importance of nuclear power in energy diversification, low carbon emissions and as a way of enhancing national security (Muhammad Amir & Zeler, 2024). With climate ambitions under the Paris Agreement, and the need to decarbonize, nuclear energy is a non-intermittent, large-scale, low-carbon source of energy that can meet base-load power demands (Fernández-Arias et al., 2024). However, despite India with its technical expertise and advanced nuclear infrastructure, the nuclear energy program has been historically limited by the lack of domestic uranium reserves and the political taboo in the foreign market.

India has since liberalization in the 1990s increasingly tried to globalize its nuclear policy particularly after the Indo-US Civil Nuclear Agreement of 2008. This has provided a structural chance to obtain a uranium supply in states previously restricted such as Kazakhstan-a state which has emerged as a uranium producer of significant prominence in the world. The bilateral agreement between India and Kazakhstan to supply 5,000 metric tonnes of natural uranium in 2011 was a turning point in this course and Kazakhstan became a strategic energy partner (Pradhan, 2022).

Kazakhstan has reliability due not only to its endowments of resources but also to its position in geopolitics. Kazakhstan provides a predictable, stable, and neutral alliance unlike the suppliers in the West Asia where regional instability and alliances make the reliability of such suppliers a complex issue (Boute & Chikanayev, 2025). The fact that the country has been following the International Atomic Energy Agency (IAEA) procedures and that it actively engages in the non-proliferation activities across the globe, highlights the fact that it is a better partner in the long term to India in the peaceful development of nuclear program (Sarkar, 2022; Sajjanhar, 2013).

In addition to the transactional aspect of the supply of uranium, India and Kazakhstan are considering collaborating in nuclear science and technology. Bilateral research and development (R&D) can be availed through the possibility of joint ventures in the field of fabrication of fuels, reactor design, nuclear waste management, and advanced nuclear technologies like small modular reactors (SMRs). Early discussions between the Department of Atomic Energy (DAE) of India and the National Nuclear Center (NNC) of Kazakhstan have demonstrated the mutual interest in safety standards, regulatory alignment, and joint innovation (Muratbekova and Khitakhunov, 2024).

The move by India to reach out Kazakhstan is in its greater goal of attaining strategic autonomy in the energy sector. This is particularly necessary in the conditions of oligopolistic tendencies of the global uranium market, when the few countries-suppliers are inclined to determine the prices and conditions. Through the diversification of partnerships and investment in cooperation in R&D, India minimizes its vulnerability to shocks in the global market and asserts its position in the global nuclear diplomacy. Moreover, the new relationships between Kazakhstan and Russia, particularly in the uranium enrichment and downstream fuel cycle services, provide India with a warning and a potential point of closer interaction (Siddi and Silvan, 2023). The resources are not the only reason behind the strategic logic of the nuclear cooperation between India and Kazakhstan. It is part of a concerted change in Indian foreign policy to develop energy ties that can support its climate ambitions as well as its great-power ambitions. Through this, nuclear diplomacy with Kazakhstan would serve as a cornerstone to Indian Central Asian outreach- a meeting point of technology, geopolitics, and sustainable development. The relationship is also a smaller part of a larger strategic recalibration in which Central Asia is not viewed as just an alternative supplier, but as a full partner in the energy future of India.

2.10 Repositioning Central Asia in India's Energy Doctrine

The recalibration of energy diplomacy in the 21st century highlights how India must enhance its energy security and gain greater geopolitical independence. Central Asia, which has been deemed as a periphery in Indian energy calculations, is now being re-conceived as a major strategic energy partner in its energy doctrine. This reorientation has been necessitated by a critical assessment of the shortcomings of its traditional supply networks by India particularly that relies on maritime chokepoints or political unstable

geographies. This region can be diversified not only with the variety of hydrocarbons, uranium, and hydropower but also may be an alternative paradigm of energy resilience. Rather than Central Asia being a fallback option, India is making it a part of a strong and multipolar energy policy. This shift gives preference to long-term, diversified relationships to the disadvantage of episodic and transactional relationships. The unreliability of the West Asian oil stream and the vulnerability of the sea supply lines have increased the attractiveness of politically moderate suppliers, linked by land. The republics of Central Asia, including Kazakhstan, Uzbekistan, and Turkmenistan, are becoming an increasingly more appealing option, with their developing post-Soviet energy systems and proven tendency to multilateral cooperation (Movkebaeva and Sadvakassova, 2021).

The fact that India is moving its relationships that were based on bilateral interactions to a multilevel institutionalized energy system is particularly important. The proposed India--Central Asia Energy Coordination Group is representative of this new model, supporting cooperation in upstream exploration, nuclear safety standards harmonization, common investment, and cooperative research and development of clean technologies. These platforms do not only organize economic cooperation, but they institutionalize the mutual trust, volatility decreases, and regional stability is triggered.

India is also consolidated in the region through the integration of multilateral diplomacy. India is integrating its energy diplomacy into regional regimes, e.g. through full membership in the Shanghai Cooperation Organisation (SCO+) and the status of an observer in the Eurasian Economic Union (EAEU). At the same time, the fact that India complies with the procedures of the International Atomic Energy Agency (IAEA) supports its reputation as a reliable nuclear player- which is especially important in the context of Kazakhstan uranium deposits and previously established bilateral interactions (Hans, 2023). Against the background of the Chinese Belt and Road Initiative (BRI), as well as Russian regionalization via legacy networks, including the CSTO, an Indian distinct energy engagement pattern can be witnessed. Soft power diplomacy that offers educational connectivity, capacity building and institutional establishment are used instead of applying capital intensive infrastructural reliances to India. Though not giving immediate infrastructural outcomes, this approach is less aggressive and more sustainable, which the Central Asian states would rather have when it comes to having a balanced partnership.

The current political doctrine of India is the intersection of symbolism and strategic

sense. The focus on Central Asia portrays a greater shift in India foreign policy imagination- insular realism to active regionalism. A vision of flexibility, resilience, and positive multilateralism is strengthened by New Delhi through recognizing Central Asia as an interlocutor in the creation of energy governance and economic connectivity. This repositioning presupposes more than the geographic pragmatism- it presupposes a paradigmatic change of the energy doctrine of India. Not merely a change of supplier dependency into diversified sourcing, it is a change of transactional relationship into visionary partnership. It offers a high futuristic plan that is in line with global interdependence and systemic risk and the pressing necessity of sustainable energy transitions. Central Asia, in its turn, will be one of the experiments of how India can introduce energy diplomacy into its bigger project of strategic independence and global visibility.

2.11 Conclusion

The analysis in this chapter establishes that India's energy vulnerability is multidimensional and cannot be addressed solely through increasing domestic production. Import dependence, geopolitical instability, infrastructure constraints and the transition towards a lower-carbon energy system collectively require diversification and strategic resilience. Within this context, Central Asia has emerged as an important component of India's external energy strategy, with Kazakhstan occupying a particularly significant position because of its uranium resources and geopolitical importance.

The chapter also demonstrates that India's Central Asian policy has evolved from diplomatic outreach towards a broader strategy involving energy, connectivity, trade, security and strategic partnerships. Nevertheless, geographical barriers and the competing influence of China and Russia constrain India's ability to translate diplomatic intent into structural influence. These findings provide the contextual foundation for the next chapter, which examines the evolution, institutionalisation and practical implementation of India–Kazakhstan nuclear cooperation in greater detail.

CHAPTER 3
EVOLUTION AND IMPLEMENTATION OF INDO-KAZAKHSTAN NUCLEAR COOPERATION

3.1 Introduction

The strategic environment of India-Central Asia interaction, which has been discussed in the preceding chapter, is where the strategic focus of their desired collaboration in the nuclear energy sector with Kazakhstan is seen. This move towards a regional perspective to a bilateral case study is a reflection of the singular status of Kazakhstan as the largest producer of uranium in the world, with more than 40 percent of the world mined uranium in 2023 (World Nuclear Association, 2024). Its political stability, compliance with IAEA protection and stability in its multi-vector foreign policy make it a low-risk and high-trust partner in the nuclear diversification strategy of India among the volatile suppliers in West Asia. The alliance lies within the Indian quest of energy self-sufficiency, where it has control over fuel supply chains and is less exposed to geopolitical or market shocks.

The model that will be used in this analysis is the notion of energy affinity-a long-lasting convergence of the strategic, economic and technological interests between two states in the energy arena. In the case of the Indo-Kazakh, this goes beyond the uranium trade to encompass civil nuclear cooperation agreements (CNCAs), joint research, and multilateral coordination. The necessity to expand the export base of Kazakhstan outside of Russia and China (Behera and Gubaidullina, 2018) and the necessity of India to have diversified and long-term supplies of nuclear power to support its three-stage programme justify this relationship. The initial phase, which relies on Pressurised Heavy Water Reactors (PHWRs) is highly reliant on imported natural uranium, and Kazakhstan is a major exporter of the same.

Conceptually, the theory behind the process of Securitization (Securitization Theory, Buzan et al., 1998) describes the way uranium acquisition has been introduced in the policy discourse in India in the context of a national security imperative. Policymakers rationalize extraordinary diplomatic and institutional responses, including making uranium acquisition a priority in strategic discussions and circumventing the procedural hurdles in bilateral discussions, by securitizing the fuel supply challenge. This is matched with the structural

power framework of Strange (1996) which explains why Kazakhstan can use its oligopolistic market status to influence the uranium pricing, terms of contracts and reliability in delivery hence affecting the stability of the Indian civilian nuclear programme.

The geographical location of Kazakhstan as the crossroad of Eurasia can strengthen its role in the long-term strategy of India. It is strategically positioned with overland access routes through the International North South Transport Corridor (INSTC) and other connectivity options through the Chabahar Port. Although promising, these corridors are susceptible to security changes in Afghanistan (Asatryan, 2025) where unstable conditions may cause disruption in supply lines. However, the presence of stable governance and the multi-vector foreign policy in Kazakhstan help to eliminate such risks as the country has a balanced relationship with various great powers and regional blocks and can cooperate with them despite the external pressure.

Indo Kazakh nuclear cooperation is relevant in terms of its strategic and operational relevance as far as the case is concerned. The 2011 Indo Kazakh CNCA (World Nuclear News, 2011) was agreed to provide 5, 000 metric tonnes of natural uranium with an agreed schedule of supply, renewing clauses and the presence of IAEA in the process. This deal with the help of the 2008 Nuclear Suppliers Group (NSG) waiver was a turning point in India entering the nuclear market in the world (Sajjanhar, 2013). The two renewals in 2015 and 2019 have strengthened the impression about Kazakhstan as a stable and irreplaceable partner.

In the following chapter, the historical development of Indo-Kazakh nuclear cooperation will be examined, the legal and institutional framework of uranium commerce will be surveyed, the performance of trade will be analysed, the technological and scientific cooperation beyond fuel will be discussed, the partnership will be placed in the context of a competitive geopolitical landscape, the policy and institutional limitations will be analysed, and the role of Kazakhstan in the net zero and long term strategic energy plans of India will be projected. The paper will also look at how the multi vector diplomacy, structural power, and complex interdependence interrelate in maintaining this bilateral relationship. The chronicle of the milestones starts with the time when India recognized the independence of Kazakhstan in 1991 and the development of the diplomatic relations in the same year. During the 1990s and early 2000s, lack of cooperation was limited due to lack

of inclusion in the NSG which limited uranium imports by India. This situation was altered with the 2008 NSG waiver following the Indo-US Civil Nuclear Agreement and this led to the 2011 CNCA. By 2024, Kazakhstan was among the three biggest suppliers of uranium to India, alongside Canada and Russia, and this has ensured resource security during a time of unstable world uranium prices and escalating geopolitical competition.

To comprehend theoretical premises and strategic necessities of Indo-Kazakh nuclear cooperation, one has to take a close look at the historical underpinnings of this cooperation. As the history of this relationship shows that dates back to the independence of the sovereign state of Kazakhstan in 1991 and the radical change of the waiver of the NSG in 2008, the political will, marketplace realities as well as security perceptions gradually turned into the relationship of the highest strategic value. Using this trajectory, the original diplomatic probes, institutionalised arrangements, and market cues that preconditioned the formalisation of uranium supply arrangements of the 2010s can be isolated. The next section is therefore a reconstruction of the pre 2008 period, highlighting how India was functioning on the terms and conditions of NSG and how Kazakhstan was re-established in the post-Soviet nuclear order and how all these developments working together hastened the beginning of long term cooperation in the decades that followed.

3.2 Historical Evolution of Indo–Kazakh Nuclear Engagement (1991–2008)

Indo-Kazakh nuclear interest can be traced back to the strategic reconfiguration of the post-Cold War period that occurred in the aftermath of the collapse of the Soviet Union in December 1991. The initial diplomatic acceptance of Kazakhstan as a sovereign nation, in February 1992, and the swift establishing of embassies in New Delhi and Almaty, was a move by India to establish a long-term relationship with the biggest Central Asian republic. Early high-level visits in the 1990s-mainly of an exploratory and symbolic nature-surveyed common ground in trade, investment and regional security. Nevertheless, the nuclear cooperation did not feature in official agendas. This was not because they were unaware of the uranium resource at Kazakhstan but because of the binding obligation imposed by the exclusion of India in the Nuclear Non-Proliferation Treaty (NPT) and the urgent need of Kazakhstan to decommission its inherited nuclear weapons and conform to the world standards of non-proliferation.

It was also during this period that the so-called energy affinity was born, a long-

lasting convergence of strategic, economic and technological interests in the energy sector, between two states. The interests of India and Kazakhstan, in this case, were to find safe supplies of uranium to serve its civilian nuclear programme and to establish itself as a credible and politically neutral supplier in the international markets. This affinity was latent, limited by barriers to international law, but the structural basis started to be established in the 1990s in the goodwill of diplomacy, initial trade connections, and similar strategic goals.

The process of nuclear disarmament in Kazakhstan was key in developing the international credibility of this country. It inherited the fourth-largest nuclear arsenal in the world at independence - more than 1,400 strategic warheads, intercontinental ballistic missiles and heavy bombers mostly at the Semipalatinsk Test Site and the Baikonur Cosmodrome. The period of irreversible disarmament in Kazakhstan took place between 1991 and 1995 when it joined the NPT as a non-nuclear-weapon state in 1994 and declared all nuclear-related facilities under IAEA protection (Kassenova, 2024). Major powers security guarantees, economic burdens of nuclear infrastructure and the strategic objective of projecting a responsible international image are some of the factors that influenced this decision. According to the Nuclear Threat Initiative (2023), through collaboration with the United States and Russia via the NunnLugar Cooperative Threat Reduction Program, delivery systems were destroyed, fissile material was secured and transparency institutionalised. This compliance legacy would prove to be a decisive point to the potential partners including India as they appreciated the effort Kazakhstan made in ensuring non-proliferation.

In the case of India, the pre 2008 years were characterized by the Indian country being denied entry into the global civil nuclear trade because of their 1974 and 1998 nuclear tests in the form of Nuclear Suppliers Group (NSG) sanctions. These limits led to structural fuel bottleneck. The amount of uranium available domestically was not even enough to serve the small fleet of Pressurised Heavy Water Reactors (PHWRs), leading to less-than-optimal capacity factors in the reactors and slow-paced expansion plans (Curtis, 2007; Bucher, 2009). According to Grover (2017), nuclear planning during this period in India was defensive because it depended on local mining and processing to keep its operations going and lobbying to be eventually reintegrated into the international markets. Comparatively, although other potential suppliers like Australia and Canada had large

supplies of uranium, their export policies were in line with the NSG guidelines, and thus they were not available to India until the end of legal restrictions. Despite being similarly committed to non-proliferation commitments, Kazakhstan faced less political tension in its relations with India and a geopolitical orientation that would allow it to collaborate with the country in the future.

Although nuclear trade was never officially established, in the late 1990s and early 2000s, there were initial signs of cooperation, via Track II diplomacy and non-nuclear economic activity. Nuclear energy cooperation started to be mentioned in business conferences, academic exchange and even in scientific delegations as a long-term objective. According to the analysis of the ETH (2008) of the context of the NSG waiver, it can be seen that even before the waiver, the country of Kazakhstan was perceived in the circles of the Indian policymaking as a high-priority post-waiver partner with its resources being seen as great, its export capacity being seen as consistent, and its foreign policy position as balanced.

The organization of the uranium sector in Kazakhstan at this time can be considered through the prism of area studies, with the remnants of Soviet central planning and the slow incorporation of market-oriented reforms defining the organization of that sector. As evididenced by Ospanova et al. (2008) uranium mining and processing was still controlled by the state with the national company having the final say as far as exploration, production quotas and exports were concerned. The report by Stanford University (2010) points at the ubiquitous state in the entire uranium value chain-exploration, extraction, milling and export-that guaranteed the strategic control but reduced the pace of technological modernisation. Incremental reforms, however, by the mid-2000s, introduction of in-situ leaching and stable production management has brought Kazakhstan to the top three uranium producers in the world with cost-effective extraction and predictable schedules of delivery (Eurasian Research Institute, 2017). This production profile is a demonstration of an early manifestation of structural power (Strange, 1996), whereby the market position of Kazakhstan gave it a potential gain of influence over the pricing norms, contract design, and even the security of supply-before it was integrated fully into the procurement strategies of India.

The interplay of chronic fuel shortages in India under NSG isolation, the image of a compliant and stable nuclear player developed by Kazakhstan, and the maturation of its

uranium business, led to the structural conditions of a future alliance. Though direct uranium trade had been explicitly forbidden by law prior to the NSG waiver, the long-standing relationship between the two countries had built up a pool of trust, understanding of strategic necessity, and technical compatibility. All these factors were ready to be mobilized by 2008. Cooperation between Indo Kazakh on the nuclear front did not come into existence with the NSG waiver but it paved the way to a cooperation that had been politically, industrially, and strategically fostered over nearly two decades.

The period of 2008 before relations with Indo Kazakh is a structurally prepared period not policy inertial period. Diplomatic goodwill, common orientation in the objectives of strategic energy, and the fact that Kazakhstan had grown into a credible, structurally strong uranium producer had already defined the parameters of a viable partnership. But these parameters were latent and the export control regime of Nuclear Suppliers Group curtailed the same. This reached its climax in September 2008 with the NSG waiving India to enable it to join the world wide civil nuclear trade despite the fact that India was not a signatory of the NPT. This action altered the strategic calculations of the two states per se. In the example of India, it removed the legal barrier to the relationship with Kazakhstan as a source of uranium; in the example of Kazakhstan it created a long term, high demand, attractive market that could be used to complement its existing export portfolio and to enhance its status as an actor in the non-proliferation architecture. The following section examines how the 2008-2010 period proved to be a strategic placement of positioning with high level diplomacy, antagonistic supplier relations and the fulfillment of bilateral nuclear cooperation systems.

3.3 The NSG Waiver and Strategic Repositioning (2008–2010)

The Nuclear Suppliers Group (NSG) waiver of September 2008 was a turning point in India nuclear diplomacy not only a procedural abacus but also a rebalancing of the rules of the world nuclear trade system. This political and legal advancement that was made possible by the Indo US Civil Nuclear Agreement made India a conditional member of the global nuclear order rather than an outsider as it has always remained. Squassoni (2010), on the one hand, notes that the waiver redefined established exclusionary policies that date back to the 1970s, whereas Tellis (2023) frames the waiver as the logical conclusion of the decades long effort by the New Delhi government to obtain access to nuclear technology

and materials without having to forego the status of a non-nuclear weapon state, thus maintaining strategic autonomy, as well as gaining access to global supply chain operation.

In the lens of regime theory, the waiver showed that the global governance systems are not only not fixed or even rules based but are reinterpreted when powerful members see strategic interest in accommodation. The sponsorship of India case by the United States was part of an enlarged geopolitical equation that sought to build bilateral relations, offset Chinese positioning in Asia, and recruit India to are constructed security order. Convincing other members of NSG necessitated a combination of diplomatic arm-twisting and economic enticements and promises of non-proliferation compliance, leading to a normative adaptation of selectivity that allowed suppliers such as Kazakhstan to gain access to the Indian market with reputational and legal impunity. This change promptly triggered a latent energy affinity--determined in previous chapters--whereby the demands of India to diversify its uranium imports intersected with the interest of Kazakhstan to diversify its export markets.

The strategic repositioning of Kazakhstan since the waiver was a product of both the logic of the external market and internal politics-economics. Relying historically on Russia as a source of enrichment services and export routes, Astana aimed to curtail overdependence on a single partner to increase bargaining power and protect its independence in resource diplomacy. According to Siddi and Silvan (2023), the multi-vector foreign policy of Kazakhstan had long been focused on the balance of great-power relations, even though domestic priorities, such as the strategy of industrial development and the consensus of the elite on the necessity to diversify the economy, supported the desire to enter the high-growth markets, such as India. The Indian market was strategically appealing, with an increasing demand and willingness to sign long-term contracts and no negative experiences on the history of this market. Kazakhstan also enhanced its structural power (Strange, 1996) in the uranium market, using its dominant portion of world production to influence price negotiations and contract terms, by positioning itself as a neutral, rules-compliant supplier, working within IAEA safeguards.

The landscape of regional suppliers was also reconfigured by the waiver. Although still firmly established in the Kazakh uranium industry, Russia saw an opportunity in the new market opportunity offered by India in its uranium industry to build its own reactor construction and fuel deals with India and so complementary rather than barring entry into

the industry by Kazakhstan. China, however, saw this waiver by India with greater reservations and saw it as an American-supported strategic advantage of New Delhi in the Asian balance sheet. Even though Beijing did not hinder the Indian outreach by Kazakhstan, it proceeded to make sure that its long-term supply arrangements remained strategic in its Belt and Road energy corridors. This competitive context also encouraged Kazakhstan to clinch an agreement with India as soon as possible not only to secure a big non-Western client but also to signalize its capability to balance competing great-power interests.

The 2008-2010 years of the post-waiver were thus marked by a thick stream of high-level bilateral interactions in order to transform new legal opportunities into long-term business solutions. Mohan and Agarwal (2019) record the synchronisation of ministerial visits with multilateral forums like the SCO to enable side-line negotiations and the signing of multiple Memoranda of Understanding (MoUs) in mining, geology, hydrocarbons and space cooperation- broadening the base of cooperation and integrating nuclear trade into a broader web of strategic interdependencies. In the case of India, this was a securitised supply of uranium (Buzan et al., 1998), but this is not a commercial good, but an asset of national security, needed to ensure the continuation of the three-stage nuclear power programme. In the case of Kazakhstan, it was the operationalisation of a diversification strategy that had long-term development that not only enhanced economic resilience but also geopolitical autonomy.

By late 2010, all three legal, institutional and political frameworks of the historic 2011 Civil Nuclear Cooperation Agreement were in place. The NSG waiver had not only triggered a bilateral realignment, but also a rearrangement of supplier relations within Eurasia, positioning Kazakhstan as a part of Indian energy security but allowing Astana to establish itself as a globally relevant, norm-compliant uranium supplier. The following section examines how these preparatory moves were solidified in the provisions, safeguards and strategic reasoning behind the 2011 agreement.

The repositioning of 2008-2010 was, therefore, a planned pre-negotiation period where the legal barrier was broken, the strategic incentive was harmonized and the institutional channels of uranium trade was prepared. Through the coordination of normative adaptation at the level of the NSG with bilateral diplomacy, India and Kazakhstan were able to make sure that the 2011 agreement would not be a one-off deal

but the initial formal statement of a long-term strategic energy relationship. The preparatory MoUs, ministerial exchanges and parallel sectoral cooperation established a thick web of interdependence whereby a single-issue dispute was unlikely to be used to jeopardise the nuclear trade relationship. This implied that the signing of the Civil Nuclear Cooperation Agreement in April 2011 could include not only arrangements of the supply of 5,000 metric tons of natural uranium but also verification and renewal and price mechanisms based on mutual trust and strategic long-term vision. The following section breaks down the substantive terms and the bargaining dynamics of the agreement and demonstrates how the agreement structure operationalised the strategic, economic, and political goals found in the post-waiver repositioning period.

3.4 The 2011 Civil Nuclear Agreement

The legal, diplomatic and strategic underpinnings of the post waiver repositioning process of 20082010 naturally climaxed with the signing of the Indo Kazakh Civil Nuclear Cooperation Agreement in April 2011. It was an agreement between Kazakhstan and India to supply 5,000 metric tonnes of natural uranium over a multiyear agreement with tranches that could be changed based on the operational requirements and market conditions (Economic Times, 2015). The flexibility offered by the renewal provisions ensured that both parties were given an opportunity to renew the supply and the pricing was pegged to the world uranium standards in order to ensure that it was competitive in the market without compromising the security of supply. These features of the contract were the operationalisation of the energy affinity where the Indian need of stable long term supply and the Kazakhstan need of discovering a high value and politically stable market were achieved.

Institutional responsibility was shared between India's Department of Atomic Energy (DAE) and the Nuclear Power Corporation of India Limited (NPCIL) on one side, and Kazakhstan's and Ministry of Energy on the other. This guaranteed the incorporation of political control, technical capability, and continuity in operations. The deal on the Indian side was a direct boost to the three stage nuclear power programme, which imported uranium to feed Stage-1 Pressurised Heavy Water Reactors (PHWRs), and therefore indirectly the development of Stage-2 Fast Breeder Reactor (Tellis, 2006). In the case of Kazakhstan, the agreement has tightened its structural power (Strange, 1996) in the

uranium market as it solidifies its status as a key supplier to one of the fastest-growing nuclear energy markets, which strengthens its ability to control the prices, contract norms, and the reliability of supply.

A competitive environment among suppliers influenced the negotiation environment. Australia, even with a large amount of uranium reserves, continued a ban on sales to non-NPT signatories until the end of 2011, and did not have an active bilateral system with India at the time (East Asia Forum, 2020). Canada was involved in protracted negotiating safeguard and reactor technology agreements, which postponed timely deliveries. Although Russia is a reliable partner, it already controlled the nuclear technology portfolio and enrichment supply in India, making New Delhi worried about dependence on suppliers. Kazakhstan therefore became the best option; combining high production potential, cost-effectiveness, non-proliferation credibility, and political neutrality. Its multi-vector foreign policy also convinced India that the supply of uranium would not be exposed to great power rivalry.

The finalisation of the deal was not instantaneous; it was the product of sustained high-level engagement. A series of ministerial visits, SCO-side conferences and inter-agency consultations between late 2009 and early 2011 slowly sorted out commercial, logistical and safeguard details. These were strengthened by non-nuclear sector MoU's in mining, geology, hydrocarbons and space-that enhanced overall bilateral confidence and provided more avenues of dialogue. The integration of nuclear cooperation into a wider context of economic and scientific cooperation helped both states to minimise the chances of destabilising the agreement because of sector-related conflicts. Checks and balances played a key role in the validity of the agreement. The uranium they provided all came under the supervision of the International Atomic Energy Agency (IAEA), and included provisions requiring compliance with IAEA standards in material accounting, safe transportation, and end-use inspection (Hibbs, 2015). Frequent reporting and inspection policies formalised transparency, appeasing NSG anxieties and strengthening the image of Kazakhstan as a law-abiding supplier. For India, these procedures ensured that imports could proceed without political resistance from other NSG members, while also bolstering its image as a responsible nuclear actor.

As a matter of area studies, the timing and format of the agreement were influenced by the domestic politics in Kazakhstan. The centralisation of executive power into the

hands of President Nursultan Nazarbayev and his focus on the so called multi-vector diplomacy had given the political stability and policy consistency required to seek long term strategic contracts. The fact that the uranium industry was treated as a strategic national industry implied that the transaction was supported by the top political echelon, and the bureaucracy was aligned with the transaction as well as the implementation process was swift.

The agreement in 2011 was not only linked to immediate supply. In the case of India, it has diversified the nuclear fuel mix that has over depended on Russia and New Delhi is in a better position to negotiate with other sources. To Kazakhstan it was a demonstration of high visibility that it could compete in a politically sensitive high value market and be in strict non-proliferation compliance. Both of these successes solidified the agreement into the centre of the Indo-Kazakh strategic partnership and its future renewals in 2015 and beyond proven to be a testament to its continued applicability to the energy and foreign policy interests of both states.

The Civil Nuclear Cooperation Agreement of 2011, therefore, took the Indo Kazakh nuclear cooperation out of the strategic planning space to the quantifiable operational sphere. Institutionalising a long term supply commitment under IAEA safeguards, the agreement gave the framework to uninterrupted deliveries, stable prices and politically assured cooperation. However, such partnership is not only sustainable based on the design of the contract but also its practice. The post 2011 years provided a test of the resilience of the agreement-whether Kazakhstan could supply reliably at fluctuating global uranium prices, shifting market demand and changing geopolitical pressures, and whether India could manage to absorb Kazakh uranium in its three stage nuclear power programme without causing new dependencies. This performance record is discussed in the next section, providing quantitative data on deliveries, evaluating the relative positions of suppliers and analysing market and political drivers that influenced Indo-Kazakh uranium trade in the period 2011-2024.

3.5 Uranium Trade Performance: 2011–2024

The actualisation of the Indo-Kazakh Civil Nuclear Cooperation Agreement of 2011 has taken a diplomatic relationship into a palpable flow of nuclear fuel supply (World Nuclear News, 2011). The agreement has been put to test through many delivery cycles,

market situations, and geopolitical shocks over the last thirteen years, and has proven to be very reliable and of high strategic value (Kazatomprom, 2024; NEA, 2025). This trade arrangement can be conceptually viewed to have performed in three general stages, which can be characterized by delivery modes, market situation and the changing comparative status of Kazakhstan in the Indian nuclear fuel portfolio.

Consolidation and trust building marked the first phase, between 2011 and 2014. Deliveries remained on average between 1,250 and 1,300 metric tonnes (MT) and were above the 1,200 MT contracted quota (DAE, 2015; NEA, 2025). This trustworthiness was directly linked to better performance in the operations of the Pressurised Heavy Water Reactors (PHWRs) in India with average capacity factors increasing by 65 70 percent to 80 85 percent before waiver (IAEA PRIS, 2014). The capacity to deliver beyond the promise without sacrificing other export contracts was evidence of available capacity in production and strategic decision by Kazakhstan to build a reputation of being a reliable supplier (World Nuclear Association, 2024).

The second part (2015 to 2019) commenced with the renewal agreement in mid-2015, which reconstituted the 5,000 MT commitment at stable prices and safeguard conditions (Economic Times, 2015). Deliveries averaged 1,100–1,200 MT per year as India diversified its supplier base to include Canada and expanded existing ties with Russia (NEA, 2025). Despite this diversification, Kazakhstan retained roughly 30–32 percent of India's uranium imports, outperforming Canada in delivery timeliness and maintaining lower per-pound procurement costs than Russia's enriched fuel offerings (BusinessWire, 2025). The stability of supply at this stage underscored the common ground of Stability-India wanted to reduce the dependency on suppliers and Kazakhstan wanted to retain its positions in the Asian market and its well-established European and Chinese relations. The third phase (2020-2024) challenged the supply chain resilience amid the COVID-19 pandemic and the increased market volatility. In 2020, shipments decreased to 900 MT because of transportation limitations and temporary mining halts the lowest in the history of the relationship. By 2021, however, deliveries rebounded to 1,050 MT and stabilised at around 1,080–1,100 MT through 2023 and 2024 (DAE, 2024; World Nuclear News, 2022). This revival was accompanied by an increase in world uranium prices-between USD 30/lb U3 O8 in 2019 and USD 50-60/lb in 2023-as a result of a new nuclear investment, speculative trading, and supply worries due to geopolitical tensions (NEA,

2025; Business-Wire, 2025). The index-linked pricing provisions that Indian companies had with Kazakhstan helped to protect procurement budgets against these spikes, which affirms the strategic foresight that was incorporated in the initial contract architecture (MEA, 2016).

Comparatively, Kazakhstan has always been among the top three suppliers of uranium in India. In 2023, India had an import share of about: 28 percent of uranium (Kazakhstan), 27 percent (Canada), 25 percent (Russia), 12 percent (Australia), and 8 percent (other countries) (NEA, 2025; World Nuclear News, 2022). The competitive advantage of Kazakhstan over Canada was also in a shorter delivery lead time and the number of fewer logistical disruptions; in contrast to Russia, it was cheaper and did not face the risks of geopolitical tensions linked to great power rivalry (FT Editorial, 2025). The contribution in Australia increased gradually following the change in policy of the country to permit the export to India, with the volumes remaining relatively low (World Nuclear Association, 2024).

This trade has been closely related to wider uranium market cycles to be sustainable. Between 2011 and 2015, the spot prices fell as much as USD 70/lb to USD 30/lb due to post-Fukushima demand suppression but Kazakhstan continued to deliver steadily to retain its market share (NEA, 2025). In 2016-2019, the intentional reduction of major suppliers stabilised the prices in a range of the mid-USD 30/lb, which forced India to increase its supplier base without a significant decrease in volumes of Kazakh (BusinessWire, 2025). Since 2020, the demand linked to decarbonisation and the supply shock of geopolitics pushed the prices to the USD 50-60/lb range; during this volatility, the contractual performance of Kazakhstan supported its reputation as a supplier that is stability-oriented (Kazatomprom, 2024; World Nuclear News, 2022).

The cumulative amounts of natural uranium imported to India during the period between 2011 and 2024 were about 14,500 15,000 MT of natural uranium imported by India that was imported by Kazakhstan. This is approximately 26-28 percent of the total uranium imports in India, as well as 18-20 percent of its total nuclear fuel demand with domestic production factored in (NEA, 2025). The reliability of delivery has been over 95 percent of the scheduled volumes, PHWR capacity aspects have been more than 80 percent since 2013 (IAEA PRIS, 2023), and the pricing stability embedded in the contract has saved India an estimated USD 25 30 million per year over recent price spikes

(BusinessWire, 2025). The result of these has increased India bargaining power in the negotiation with other suppliers, and the status of Kazakhstan as a high volume, politically neutral and norm-compliant uranium provider. Going forward, the demonstrated trust and win-win approach of this arrangement is bound to have an impact on forward contracting strategy of India and the attempts of Kazakhstan to have a balanced export portfolio in both Asian and Western markets (see Table 3.1).

Table 3.1: Evolution of India–Kazakhstan Uranium Cooperation

Phase / Year	Imports from Kazakhstan	Nature of Cooperation / Significance	Source
Phase 1 (2009–2014)	2,100 tU	January 2009 agreement between Kazatomprom and NPCIL for uranium supply; also included a feasibility study for Indian PHWRs in Kazakhstan.	Kazinform (2026)
Phase 2 (2015–2019)	5,000 tU	Five-year uranium supply agreement concluded during PM Narendra Modi's 2015 visit to Astana; reflected expanded nuclear-fuel cooperation.	World Nuclear Association (2026); Kazinform (2026)
Recent Developments (2019–2022)	Not specified in the supplied sources	Consolidation of uranium cooperation and continuation of broader India–Kazakhstan strategic engagement.	Kospanov & Gusseinov (2026)
2026 Renewal Status	New long-term supply agreement; quantity not specified in the supplied sources	Shift from periodic uranium procurement toward a longer-term strategic fuel partnership supporting India's nuclear-energy security.	Chaudhury (2026); Kospanov & Gusseinov (2026)

The India–Kazakhstan uranium relationship can be systematically understood in four phases, reflecting a gradual movement from initial cooperation toward a more strategic and long-term nuclear-fuel partnership. Phase 1 (2009–2014) began in January 2009, when Kazakhstan's state-owned uranium company Kazatomprom signed an agreement with India's Nuclear Power Corporation of India Limited (NPCIL) to supply 2,100 tonnes of uranium. The agreement also envisaged a feasibility study concerning the construction of Indian pressurised heavy water reactors (PHWRs) in Kazakhstan, indicating that the relationship extended beyond uranium trade toward technological and institutional cooperation *(Kazinform, 2026)*. Phase 2 (2015–2019) represented a substantial expansion in the scale of cooperation. During Prime Minister Narendra Modi's 2015 visit to Astana, India and Kazakhstan concluded a contract for the supply of 5,000 tonnes of uranium over five years. Kazatomprom subsequently signed an agreement with India's Department of Atomic Energy for uranium supplies during 2015–2019 *(World Nuclear Association, 2026; Kazinform, 2026)*. This second phase demonstrated India's growing reliance on imported uranium to support its expanding civilian nuclear programme and Kazakhstan's emergence as a dependable supplier.

The 2019–2022 period can be regarded as a consolidation phase, in which uranium cooperation remained an important component of broader India–Kazakhstan economic and strategic engagement. The subsequent 2026 renewal marks a significant qualitative shift because the latest uranium arrangement moves beyond periodic procurement toward a longer-term strategic fuel relationship. Kazakhstan is a major global uranium producer, while India requires dependable imported nuclear fuel to sustain and expand its nuclear-energy programme. The 2026 agreement therefore strengthens energy security for India while providing Kazakhstan with a stable strategic market for its uranium production *(Chaudhury, 2026; Kospanov & Gusseinov, 2026)*. The development also demonstrates how uranium has increasingly acquired geopolitical significance within India–Central Asia relations. Rather than being treated merely as a commercial commodity, nuclear fuel is becoming an instrument of strategic partnership, energy security, and long-term diplomatic engagement. Thus, the trajectory from the 2,100-tonne 2009 agreement, through the 5,000-tonne 2015–2019 contract, to the 2026 renewal illustrates the institutionalisation and strategic deepening of India–Kazakhstan nuclear cooperation *(Kazinform, 2026; World Nuclear Association, 2026)*.

3.6 Technological and Scientific Cooperation Beyond Fuel

The sustainability of Indo-Kazakh uranium trade since 2011 has provided a platform on which an expanded nuclear relationship based on more than commodity trading can be established. Strategically, fuel supply stability, has acted as a trust-building tool, allowing both powers to consider cooperation in high-technology areas where interdependence is more complex, transaction costs greater, and institutional integration is needed. The current trend is in line with the energy affinity model described above, according to which the stable trade relations yield spillover benefits in technology transfer, research cooperation, and convergence of regulations.

Among the most evident results of this strengthening collaboration has been the bilateral research and development (R&D) collaboration between the Department of Atomic Energy (DAE) of India and the National Nuclear Center (NMC) of Kazakhstan. This partnership encompasses various high-technology areas such as safety systems of advanced reactors, improved fuel fabrication technologies, and immobilisation of radioactive waste (Press Information Bureau [PIB], 2023). The focus of joint safety research has been the use of probabilistic risk assessment models, in-service inspection technologies of ageing reactor components, and passive safety systems based on the post-Fukushima lessons of operation. In fuel fabrication, Kazakhstan, with its uranium conversion expertise combined with India with its native PHWR and Fast Breeder Reactor (FBR) fuel assembly designs have produced experimental fuel rods which are less susceptible to corrosion and thermal stress. Cooperation in waste management has given attention to vitrification process and geologic disposal site characterisation basing on the experience of the NNC in the process of post-Soviet remediation of the legacy nuclear sites.

In addition to the incremental modernizations of their existing reactor fleets, both nations have found a future-oriented area in Small Modular Reactors (SMRs). SMRs are modular, can be constructed on shorter timelines, and have better load-following characteristics, which are in line with decarbonisation goals and flexibility requirements of the energy system (Momin, 2023). In the Indo-Kazakh discourse, SMR collaboration has been conceptualised based on two-track approach: India might contribute reactor design and regulatory licensing structures, control system integration, whilst Kazakhstan might supply low-cost uranium and fabrication facilities as well as a possible regional

demonstration site. Although there is not yet a bilateral SMR project to the prototyping stage, working groups have shared technical papers in the core design optimisation, modular component fabrication, and heat exchanger systems both in electricity generation and district heating applications.

Simultaneously, regulatory congruency has become a precondition of deep technology collaboration. India and Kazakhstan have been involved in systematic interactions with IAEA Operational Safety Review Team (OSART) methodologies, incident classification frameworks and licensing procedures of next-generation reactors (AERB, 2004). Regulatory convergence is not just an exercise in compliance, but it lowers transaction costs in joint ventures, it makes potential third country exports easier, and enhances the bargaining power of both states in multilateral nuclear governance fora.

Another pillar of cooperation has been knowledge diplomacy, which is a capacity-building vehicle upon which more formal technological interactions are built. Intensive course on reactor physics, radiation shielding and decommissioning planning: Kazakh engineers, reactor operators and regulators have attended the DAE training programmes at such institutions as the Bhabha Atomic Research Centre (BARC) and the Indira Gandhi Centre for Atomic Research (IGCAR) (Department of Atomic Energy, n.d.). On the other hand, Kazakhstan uranium processing plants and geological survey units have been subject to placements by Indian nuclear engineers and mining experts, who have acquired first-hand experience of large scale in situ leach (ISL) and radiological protection procedures in mining. The collaboration has resulted in joint publications, peer reviewed, co supervised PhD theses, and joint involvement in International Atomic Energy Agency (IAEA) Coordinated Research Projects.

Although these initiatives have been broad based, structural impediments have limited the process of these initiatives to the next level of practical implementation. The NSG restricts technology transfers through the Export control restrictions under the Guidelines of the Transfer of Nuclear Related Dual Use Equipment, in the field of sensitive technology like enrichment, reprocessing and some components of advanced reactors. The Civil Liability for Nuclear Damage Act in India has supplier liability clauses that may discourage foreign collaborators to become significant contributors in terms of joint reactor projects when intellectual property or the chain of supply of the components are involved. Financial limits are also involved: nuclear R&D that is capital intensive is in competition

with other national priorities and frequently becomes delayed or reduced in scope. Knar (2024) cautions against the so-called middle science trap, when collaborative projects never progress beyond the conceptual or pilot stage because of the lack of correspondence in the levels of industrial preparedness and a mismatch in overall strategic priorities, and this risk is not hypothetical in Indo-Kazakh cooperation, especially in the development of SMR.

Strategically, the Indo-Kazakh nuclear cooperation that has moved on to the technological and scientific fronts can be described as a transition between transactional and capability centric interdependence. When the stability of fuel trade was the first source of trust, the current situation is the development of long term technological integration on the basis of joint R&D, regulatory convergence, and knowledge diplomacy which is the architecture of long term technological integration. The ability to overcome legal, financial and governance obstacles will be the factor that will define whether this cooperation will lead to deployable innovation like SMRs or will be limited to paper level agreements and pilot studies.

Indo Kazakh nuclear interaction is growing beyond the scope of nuclear trade into research and development, regulatory alignment, and knowledge diplomacy, raising the alliance to the level of a versatile strategic alliance beyond supplier consumer relations. However, the importance of such technological connections cannot be evaluated separately; their importance is in the ability to strengthen the role of Kazakhstan in the context of the Indian nuclear energy policy. Technological collaboration, in fact, enhances the strategic stability created by fuel supply reliability and inculcates Kazakhstan, not only as a reliable provider of uranium but also as an internal collaborator in Indian nuclear sovereignty, energy diversification and decarbonization. The result of such convergence in shared observance of non-proliferation norms; accommodation to structural power imbalances is that Kazakhstan is a resource provider, a collaborator in the formulation of India long term nuclear strategy. The latter part of the paper elaborates on this role, by putting Kazakhstan within the political, economic and geopolitical rationales that inform the nuclear energy doctrine of India.

3.7 Kazakhstan's Strategic Role in India's Nuclear Energy Doctrine

Kazakhstan has transformed into a trusted uranium supplier into a strategically integrated component of the nuclear energy doctrine of India. Its importance is due to the

combination of political stability, adherence to international nuclear standards, geostrategic location and its role in the diversification strategy of the Indian supply. These two features are combined to support the energy affinity and structural power models described above and explain how a bilateral relationship of resources could affect the priorities in the doctrines and bargaining power in the international nuclear order.

The foundation of the value of Kazakhstan to India lies in political stability. Kazakhstan has had an internally stable system of governance since independence in 1991 which has been based on elite continuity and a controlled political transition system (Olcott, 2010). This predictability is a stark contrast to the volatility of some West Asian suppliers where volatile regimes and security threats may disorient long-term contracts. To New Delhi where continuous supply of nuclear fuel is being considered a securitised necessity, the domestic stability of Kazakhstan presents a significant decrease in the procurement risk and increase in the reliability of forward-contracting.

The compliance advantage of Kazakhstan strengthens its strategic location. As the country that voluntarily gave up its nuclear weapons that it had inherited, Kazakhstan has integrated itself into the global non-proliferation framework, such as the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) and the full-scale International Atomic Energy Agency (IAEA) protection (Weitz, 2014). Not only does this compliance record provide India with the assurance of uninterrupted supply without political conditionalities, but it also enhances the credibility of India in multilateral nuclear governance, especially in the NSG and IAEA where having partners with norm-compliant states reduces the reputational risks associated with the non-NPT status.

Geo-strategically, the land-based Eurasian position of Kazakhstan provides India with an insurance against the weaknesses of maritime-based supply chains. Although the physical deliveries also include maritime legs, the availability of overland routes via Russia and the International North-South Transport Corridor (INSTC) introduce redundancy in the face of disruptions of the maritime chokepoints like the Strait of Malacca (Sharlapaev, 2025). The location contributes to increasing the logistical robustness of India and fits the overall multi-alignment strategy of India, which focuses on ensuring diversification of sources and pathways of strategic commodities.

Kazakhstan, in the sphere of resource security, has traditionally contributed 2628 percent of Indian uranium imports in 20111224, thus minimizing the danger of excessive

reliance on one supplier, such as Russia, or politically conditional suppliers, including Australia, before the 2011 policy change of the country (Astana Times, 2023). In contrast to Russia, where the sale of uranium to India is a subset of larger contracts to build reactors, or Canada, where the market is usually influenced by local export control arguments, the trade between Kazakhstan and India is relatively de-politicised and market-driven. This does not only guarantee competitive pricing but also makes India stronger in its bargaining power in getting favorable contractual terms with various suppliers- an articulation of structural power on the part of the buyer.

In the future, the role of Kazakhstan in the nuclear energy doctrine of India may escalate in three likely circumstances. Firstly, in the event of the tightening of global uranium markets as a result of the growth of nuclear use in OECD and BRICS nations, the current long term agreements that India has with Kazakhstan can act as a stabilising anchor (OECD Nuclear Energy Agency & International Atomic Energy Agency, 2025). Second, Kazakhstan overland connectivity would be a vital supply option in case of maritime disruption due to regional conflict or climate-related port vulnerabilities. Third, with India working toward a net-zero goal of 2070 and increasing nuclear capacity, incorporating Kazakhstan into the technology cooperation-especially in small modular reactors (SMRs) and advanced fuels-can increase its role as a supplier of fuel to a strategic co-developer.

Overall, the embeddedness of Kazakhstan in the nuclear energy doctrine of India is not only the transactional but the structural one. Its political stability, normative congruence, geostrategic position, and diversification of supply advantages intersect to form a coalition that adds to the nuclear resilience of India, its bargaining autonomy, and strategic depth. This dynamic is a way of illustrating how energy affinity can become a strategic relationship over time, which is strengthened by the structural power asymmetries that are embedded in the nuclear order of the world.

3.8 Multi-Theoretical Analysis of the Indo–Kazakh Nuclear Energy Partnership

A complex interdependence theory, a layered theoretical approach of integrating Structural Power, Complex Interdependence, and Heartland Theory, is the best way to comprehend the IndoKazakh nuclear relationship. The lenses present various yet related facets of the relationship and when they are amalgamated, they define its resilience, strategic depth, and limitations.

Securitisation Theory provides the first analytical lens. Uranium acquisition has been repositioned by Indian policy as a routine issue of energy, to a securitised priority of national survival and strategic independence. In line with (Buzan et al., 1998) and Waevers (1995), securitisation involves political elites putting an issue in a manner that makes it existential thus justifying extraordinary action in dealing with it. Uranium imports have been included in Indian parliamentary debate and Department of Atomic Energy (DAE) policy documents since the 2008 Nuclear Suppliers Group (NSG) waiver, as a requirement to keep Pressurised Heavy Water Reactors (PHWRs) operational, to sustain the three-stage nuclear programme and to shield the energy sector against external coercion. Long-term supply agreements with Kazakhstan-who have supplied 26-28 percent of the total uranium imported to India during 2011-2024-are not just considered as commercial arrangements, but rather as a national security policy tool.

According to Strange (2015), Structural Power is the capacity to influence the structures and principles according to which the activities of other players take place. The monopolistic nature of the uranium market with few suppliers dominating most of the production makes Kazakhstan have massive power as the largest producer of uranium in the world. The consistency in the delivery despite market downturns, price fluctuations, and pandemic interruptions has strengthened the norms of supplier reliability and market stability in Kazakhstan. This consistency has an impact on the procurement policies of India since any withdrawal or diversion of Kazakh supply would require renegotiation with the more expensive or politically conditional suppliers. This relationship establishes a kind of strategic dependency-moderated by diversification-that replicates the fact that structural power is best exercised in a low key way, by conditioning expectations and the operation of norms, and not by open coercion as Strange points out.

The Indo-Kazakh relationship is reciprocal and multi-channel, which is reflected in the theory of Complex Interdependence (Keohane, 1977; Coate et al., 2015). In addition to uranium trade, the collaboration involves technological cooperation, regulatory harmonisation, and common involvement in multilateral forums like the International Atomic Energy Agency (IAEA), as well as Shanghai Cooperation Organisation (SCO). This is however an asymmetric interdependence. Kazakhstan is better endowed with diversified export items-sale to China, Russia, Japan, and the EU than India with dependable alternative suppliers, especially those with low political risk and high

production capacity. This asymmetry creates greater incentive on India to ensure that political and economic relations are friendly, whereas Kazakhstan is able to enjoy the benefits of India as a stable and high volume buyer that supplements its multi-vector foreign policy. The outcome is a mutually beneficial relationship that is accompanied by leverage imbalances.

Finally, Heartland Theory (Mackinder, 2017), modernised by Brzezinski (2016), situates Kazakhstan within the Eurasian strategic geography. Mackinder's "geographical pivot" concept framed Central Asia as the key to controlling the Eurasian landmass; Brzezinski (2016) extended this logic to the 21st century, identifying the region as a zone of strategic contestation among major powers. In the Indo–Kazakh context, Kazakhstan's land-linked position, with overland corridors to Europe, Russia, and China, offers India a partial hedge against maritime chokepoints such as the Strait of Malacca. Contemporary connectivity initiatives-the Belt and Road Initiative (BRI), the International North–South Transport Corridor (INSTC), and Eurasian rail networks-have amplified this geostrategic relevance. Although the maritime leg of uranium transportation cannot be avoided, the integration of Kazakhstan into the above-mentioned corridors will help India to become less vulnerable to maritime interference and integrate its nuclear supply chains into the general Eurasian transportation system. Combining these arguments, the Indo Kazakh nuclear collaboration is not merely an exchange relationship of supplier and consumer. Its rise is explained by securitisation in the Indian policy landscape; its contribution to procurement behaviour was shed light by structural power; its mutual benefits are described by the complexity and asymmetry of mutual benefits and the Heartland Theory anchors the relation on its geopolitical background. The intersection of these logics guarantees that the alliance is not just built in the existing fuel supply requirements but also in the structural, normative and geographical framework of India long term nuclear energy approach.

The multi theoretical evaluation proves that the Indo Kazakh nuclear relationship can be maintained through overlapping several logics of security, economic, and geopolitical logics, and not by trade in commodities. However, these sources of stability within the country are operating in an external environment that is increasingly becoming competitive. Uranium business in Kazakhstan is not only a strategic resource to India but also to other key players in the world whose energy security and geopolitical ambitions overlap in Central Asia. Belt and Road existence interrelates mining investments of China,

the historical role of Russia in the supply and enrichment of reactors, and the participation of the Western suppliers creating a competitive environment, the access to the resources, control of the infrastructure, and the diplomatic opportunities are closely interrelated. In order to understand how India is able to cope with such an environment, such as the exploitation of trust with the Kazakhstan and counterbalancing in the face of competing strategic footprints, one should look past the geopolitical rivalries that have so far defined the nuclear environment of Central Asia.

3.9 Competitive Geopolitical Environment

The uranium industry of Kazakhstan is the place, where the strategic interests of several key powers clash, and the energy security interests of multiple countries intersect. Kazakhstan is at the center of the new great game of energy geopolitics in Central Asia with the largest recoverable uranium reserves and a history of stable governance (Pradhan, 2022). The Indian involvement should be interpreted through the prism of similar approaches to China and Russia, whose role-along with the multilateral processes-determines the chances and limitations of New Delhi.

The China strategy is a blend of capital intensive investment and deep penetration into the uranium value chain in Kazakhstan via the Belt and Road Initiative (BRI). China General Nuclear Power Corporation (CGN) and China National Nuclear Corporation (CNNC) are state-owned corporations that have an equity interest in major mines-including Irkol and Semizbay-through joint ventures with Kazatomprom (Pan, 2024). The Chinese investments are also accompanied by long-term supply agreements that ensure the supplies of uranium to the domestic reactors and decades of strategic reserves. Estimates of the Chinese mining and infrastructure investments in nuclear sector in Kazakhstan are in the billions, which strengthens economic leverage. Such projects are frequently accompanied by transport and energy infrastructure as part of the BRI concept (Fulton, 2025), where logistical control is guaranteed in addition to the availability of resources.

The influence of Russia is based on the industrial integration of the Soviet era and continuity of Russia after its independence, which places Russia in a historically rooted position in the nuclear industry of Kazakhstan. Rosatom has a joint venture in uranium mining, provides enrichment services, and provides fuel fabrication facilities (Finnish Institute of International Affairs, 2023). Approximately 40 percent of Kazakh uranium is

refined in Russia and then sold to end markets, providing Moscow with technical and transit power. The association is also supported by Kazakhstan being a member of the Eurasian Economic Union (EAEU) through which energy is traded and technical standards are harmonised. Nonetheless, the geopolitical consequences of the war in Ukraine by Russia have seen many states move away nuclear services by Russia, leaving a gap through which India and other suppliers could gain influence.

India's distinct approach diverges from the heavy-capital and legacy-integration models of China and Russia. It relies on government-to-government uranium supply agreements and political trust rather than large-scale equity investments. Since 2011, India has purchased 2628 percent of its uranium imports in Kazakhstan even though it does not directly own any mines in the country. Such a policy of low capital and high trust fits in the multi vector foreign policy of Kazakhstan, which does not openly associate the country with either Chinese or Russian spheres of influence. India uses the elements of high level diplomacy, cultural connections, educational and multilateral cooperation to retain influence without causing zero sum contestation.

The links between the three approaches can be seen. The equity holdings and long term contracts China has with the country can reduce the flexible export capability of Kazakhstan, which in turn, directly influence the access of India in an event of high demand years. The domination of Russia over certain components of the enrichment and transportation chain means that Russia can hold both the Chinese and Indian routes at ransom. The low capital strategy of India reduces some of the problems related to being caught in the Sino Russian rivalry but it also implies that New Delhi does not have the hard infrastructure and ownership interests that would have ensured long term supply security in a more protectionist world.

These multilateral forums as Shanghai Cooperation Organisation (SCO), International Atomic Energy Agency (IAEA), and BRICS, are useful forums when it comes to managing this competition environment. Through SCO, India is collaborating with Kazakhstan in matters of regional stability and interconnectedness of infrastructure without blatantly challenging Chinese or Russian dominance. The two states in the IAEA strengthen their credibility as actors who comply with the norms of a nuclear actor, and this gives legitimacy to bilateral cooperation. BRICS offers an opportunity to place Indo-Kazakh nuclear relations in the context of the larger South-South energy transition agenda

with the connection of uranium supply to South-South climate and development priorities.

Such risks to India in such a competitive environment are the threat of Chinese long term contracts to crowd out the Kazakh supply available, the threat of Russia using its dominance in enrichment and transit to influence trade flows and geopolitical instability in Central Asia creating obstacles to overland trade. The fact that India does not take part in equity in Kazakh uranium resources further constrains its bargaining power in a market that is likely to become tighter with an increased global roll out of nuclear development.

Forward looking scenarios give an indication of three different directions. In a cooperative case, Kazakhstan balances supply between China, Russia, and India, with the multi vector diplomacy to preserve all partners; India preserves its market share and further strengthens technological and multilateral cooperation. A scenario of competitive consolidation would increase the Chinese equity control and the Russian processing capacity would become a necessity which would dilute the Indian share unless they invest directly in the upstream production or infrastructure. In scenario of deepening strategic partnership, India is more advantaged as it seeks to engage in joint mining operations, technology collaboration and joint logistics agreements and thus insures its fuel security against Sino Russian pressure.

Altogether, the net of capital, physical infrastructure and diplomacy predetermines the uranium business of Kazakhstan. China and India are both located in the same strategic space and have their rivalry in terms of capital driven entrenchment by China, legacy industrial integration by Russia and trust based diplomacy by India. The ability of India to convert the political trust into more tangible economic and infrastructural interests and continue to turn to multilateral diplomacy to shift to a dense and competitive geopolitical space will decide its ability to sustain and expand its presence.

The dynamics between the Chinese capital investment, the penetration of Russian legacy and the trust-based diplomacy of India indicate that the uranium sector in Kazakhstan is not an economic game to play, but it is a geopolitical game of balance. Although the strategy has so far helped India to keep a meaningful access without a face-on collision, it will be up to India to sustain and develop this position by bargaining not only of external but internal limits in the policy and the institutional structure of both partners. Law regimes, liability, infrastructural dependencies, bureaucratic inertia can all structurally brake the even the most strategically congruent alliances. These restrictions are

significant to establish the feasibility and sustainability of Indo Kazakh nuclear cooperation within a more resource limited and congested global environment. These policy and institutional challenges are discussed in the following section.

3.10 Policy and Institutional Constraints

The Indo Kazakh nuclear cooperation, even with its strategic complementary nature, is involved in a thick web of legal, infrastructural, bureaucratic, market, and policy-driven constraints. These constraints do not diminish the fundamental stability of the partnership, but have the potential to slack off or limit its scope, especially in those areas other than the trade of raw uranium, like integration of technology, joint ventures, and capacity building over time.

The first structural obstacle is the Civil Liability for Nuclear Damage Act (CLNDA), 2010 (India), which is not in line with the international standard as it provides operators with a right of recourse over suppliers in case of an accident. Although created to modernise the compensation mechanisms and safeguard the public safety (Hariharan, 2011; MP, 2014), Section 17(b) enables the Nuclear Power Corporation of India Limited (NPCIL) to recoup the expenses up to the value of the contract in case of an incident caused by defective materials or equipment. This has been seen as a risky legal environment by the suppliers (Sharma, 2023) and foreign Partners-Kazakhstan among them are cautious of partnership ventures whereby they can share the design of the components or even fabricate some (Naik and Srinivasan, 2014). By comparison, partnerships with Russia and China in Kazakhstan are structured in systems with full operator liability (as with the domestic model in Russia) or sovereign guarantee systems (as with Chinese joint ventures), and facilitate more intensive technical collaboration.

There is an additional vulnerability of connectivity. The uranium imports of India via Kazakhstan depend on multimodal transport networks that incorporate onland routes across the Eurasian continent as well as sea routes. The main alternatives to the conventional maritime routes are the International North-South Transport Corridor (INSTC) and the Chabahar Port, which are not without risk. The road and rail networks of Chabahar are still vulnerable to the political instability and security disturbances in Central Asia (Wani, 2024). INSTC has a lack of complete infrastructure, delays at the customs zone, and seasonal fluctuation of transit through the Caspian Sea (Khan and Koch, 2024).

In comparison, the direct rail and pipeline transport of uranium in China to Kazakhstan reduces uncertainty in transit, and Russia enjoys integrated Soviet-era networks of logistics.

Agility in operations is also limited by institutional inertia in the nuclear governance of India. The department of atomic energy (DAE), ministry of external affairs (MEA), and NPCIL have a history of not working parallel but in a sequence, which introduces delays in the procedures. The process of contract renewals may require 12-18 months between first negotiation and final signature, and technology transfer agreements will have to pass through several legal and inter-ministerial approval steps. There is no bilateral nuclear cooperation council standing, so the follow up can be approached on a case-by-case basis as visits to the high-level authorities and is not structured into joint committees as is the case in the cooperation in Kazakhstan with Russia and China.

The partnership also faces risk due to fluctuations in the global uranium market. Prices have fluctuated sharply: over USD 70/lb U_3O_8 in 2007, below USD 30/lb post-Fukushima (2011–2016), mid-USD 30s during supply tightening (2016–2019), and USD 50–60/lb amid the 2021–2024 nuclear revival (see table 3.2).

Table 3.2: Historical Spot Prices for Uranium (U_3O_8)

Year	Avg. Price (USD/lb)	Key Drivers
2007	72	Commodity super-cycle, rising nuclear demand
2011	55	Pre-Fukushima peak
2013	34	Post-Fukushima slump
2018	29	Prolonged oversupply
2021	40	Supply tightening
2023	56	Decarbonisation push, geopolitical tensions

Although index-linked contracts offer some protection to India, high prices sustained raise the cost of procurement and low-price cycles are an incentive to suppliers to sell at the spot. Equity domination in Chinese controlled mines in Kazakhstan means that these countries can internalize price changes, and vertical integration in Russia shields its

market, providing them with structural advantages over the import-dependent Indian model.

In the view of Kazakhstan, the multi-vector export diversification is a priority strategy; it balances shipments to Asia, Europe and North America. Authorities have also shown intentions to increase domestic nuclear power production, which would gradually decrease the export volumes in the next ten years. This diversification strategy not only avoids over-dependence on any single buyer, but also restricts the capacity of India to negotiate terms of preference, without raising its ownership-stake in upstream operations.

These constraints are proactive and they will hardly go away unless they are given specific interventions. A reform of the liability law or establishment of sovereign indemnity systems might open up more technology cooperation. Geopolitical exposure would be minimized by diversifying transit routes beyond Chabahar and INSTC-via Middle Corridor rail connections. This might also be done through the creation of a permanent Indo-Kazakh nuclear cooperation council with the mandate of technical and commercial follow-up to improve institutional efficiency. Lastly, with its net-zero 2070 objective and intended tripling of nuclear capacity, obtaining a more integrated presence in the uranium value chain of Kazakhstan, possibly through joint ventures, is not only possible, but could be vital to long-term energy security.

3.11 Kazakhstan in India's Long-Term Strategic Energy Vision

The contribution of Kazakhstan to the energy prospective of India is not limited to its current position of being a reliable supplier of uranium. It is becoming a strategic ally of decarbonisation, regional relationships, and development of technology in India. By the year 2070, when India is expected to achieve its 2070 net-zero the nuclear energy is expected to provide 12-14 percent of total electricity generation which will demand a six- to eight-fold increase in installed nuclear capacity and annual uranium demand to increase by 4,500-5,000 tonnes compared to the current level of 650-700 tonnes A reliable and high-volume uranium supply at predictable contractual prices with Kazakhstan will become vital to maintaining the operations of the reactors and avoiding disruptions in the fuel cycles as the nuclear fleet grows.

Incorporation into the net-zero strategy becomes the priority on the nearest future.

The trustworthiness of Kazakhstan as a large-volume supplier minimizes the exposure of India to the volatility of the world uranium market and the politically conditional uranium suppliers. This stability enables India to plan more sophisticated reactor deployment-including Indigenous PHWRs and possible SMRs-based on a sound fuel security basis. Conversely, although Russia provides package offers of supply and reactor, its geopolitical risk profile has increased since 2022; and although China has developed its nuclear industry at an impressive pace, its production of uranium is mainly focused on domestic demand, which restricts its export capabilities.

Beyond-energy dimension is a medium-term strategic objective, which focuses on using nuclear cooperation to further develop bilateral relations in the areas of security, education, and technology. The security background through historical defence cooperation, counter-terrorism coordination, and joint training exercises (Sajjanhar, 2013) can be applied to nuclear security and cyber-protection of critical infrastructure. Education connections via joint degree programmes in nuclear engineering, reactor safety and energy economics would result in a common pool of technical professionals. Joint research and development of advanced fuels cycles, high-temperature reactor materials and radiological safety would enhance the technological self-sufficiency of both states. An institutionalisation is a structural demand of long-term resilience and efficiency. Forming an India-Kazakhstan Nuclear Cooperation Council-comprising senior officials of the Department of Atomic Energy (DAE), the Ministry of External Affairs (MEA), Kazatomprom, the Kazakhstan Ministry of Energy, and nuclear regulators- would provide an enduring platform of strategic planning, contract oversight, and dispute resolution (Singh, 2015).

The India-Kazakhstan relationship is not as well-coordinated as in Kazakhstan; unlike the structure of joint committees with Russia and China, where problems can be solved almost instantaneously, the relations between the two countries are still based on high-level visits and ad hoc coordination, introducing procedural delays. An enduring institution would help coordinate working schedules, facilitate clearances, and combine technical and diplomatic pathways. The need to have resilience planning is long-term especially with the competitive geopolitical environment. The leverage provided to China by the equity-based control of some of the mines in Kazakh and Russia by dominating the enrichment and transit routes, a leverage that India does not have at the moment. India has

to hedge against these risks by diversifying transit routes other than the International NorthSouth Transport Corridor (INSTC) and Chabahar Port, consider Middle Corridor rail links through the Caspian, and enter into multi-route logistics arrangements. Price-indexed contracts that run on a long-term basis would hedge volatility, and uranium conversion and fabrication joint ventures would somewhat offset the absence of upstream ownership in India. Coherent safety and security measures in accordance with IAEA requirements, as well as domestic stockpiling capability, would enhance the resilience of the supply chain further (Muratbekova, 2017).

Securing integration of Kazakhstan into the net-zero strategy of India is the urgent need in the strategic hierarchy; institutionalisation is a mechanism that allows enlarging to beyond-energy cooperation, and resilience planning is the guarantee of ability to survive future geopolitical and market shocks. Through this multi-layered strategy, India will be able to make the Indo-Kazakh nuclear relationship more of a resource-based relationship, rather than a pillar of its long-term strategic energy outlook, entrenching it as part of the global shift to low-carbon energy systems.

CHAPTER 4
INDIA'S PROXIMITY WITH KAZAKHSTAN-RECASTING THE PILLARS

4.1 Introduction

The Indian-Kazakh partnership especially in the area of nuclear energy collaboration has developed into a significant component of the Indian Central Asian policy. As it has been determined in the previous chapters, this two-way interaction has been affected by reciprocal economic and strategic interests, most glaringly by the long-term uranium supply agreements that have underpinned the civilian nuclear programme of India since 2011 (Singh, 2015a). The current chapter answers one of the main research questions mentioned in the synopsis: How does India position itself among rival external players in the uranium industry in Kazakhstan and what do the consequences of this positioning mean to its future nuclear energy security? This question is directly connected to the hypothesis that the Indo-Kazakhstan uranium transaction is not only a commercial agreement, but a structural force of their strategic alliance, defining the policy directions of both countries in the energy security sphere.

Practically, the energy vulnerability of India, which is based on the scarcity of domestic sources of uranium, justifies the need to have continuous access to Kazakh resources as a strategic necessity. However, as Kazakhstan's uranium sector becomes an arena of competition among major powers, including China, Russia, the United States, the European Union, and Japan (Tumanshiyev et al., 2024), New Delhi faces the dual challenge of maintaining its market share and securing favourable contractual terms in a tightening supply environment. The instability of the current structure of this affiliation necessitates the re-casting of the pillars of this relationship with three intersecting trends. To begin with, the geopolitical backlash of the Russia-Ukraine war has destabilized the global nuclear fuel supply chains as consumer states seek to diversify the Russian circuit enrichment and supply chains. Second, the world uranium market is in a period of supply tightness, and since 2021, the price has increased drastically because of investment in nuclear power again in the framework of net-zero plans.

Third, Chinese increasing dominance of the equity in Kazakh uranium mines and through joint ventures and building of infrastructure in the Belt and Road Initiative (BRI)

poses the risk of diminishing Kazakh flexibility in its export of uranium, which will ultimately crowd out other buyers. In this competitive environment, policy should change to the current stance of the Indian government of wide use of high-trust government to government arrangements where no upstream participation is a combination of diplomatic, economic, technological, and logistical efforts. In critically evaluating the structural advantages and the weak points of the Indo and the Kazakh nuclear collaboration, it should be contextualized with the larger currents in Central Asian energy geopolitics.

4.2 Theoretical Framework

The theoretical perspectives which anchor analytical basis of this chapter are four interrelated perspectives including- Securitization Theory, Structural Power Theory, Complex Interdependence Theory and Heartland Theory. Collectively, these frameworks bridge the gap by giving complementary perspectives through which to investigate not only the past development of the Indo-Kazakhstan nuclear partnership, but also the future path. The respective explanatory power of each theory is unique: Securitization Theory is used to explain how cooperation in nuclear sphere becomes a de facto case of strategic necessity; Structural Power Theory serves to illuminate asymmetries of management over assets and the ability to make decisions; Complex Interdependence Theory helps to show the multidimensional character and asymmetries of bilateral relations; and Heartland Theory puts cooperation into the context of regional geopolitical and geo-economic processes of Eurasian region.

Securitization Theory

The Securitization Theory proposed by Buzan et al. (1998) and, further, edited by Bourbeau (2011) focuses on how a particular issue is constructed as an existential security threat, which necessitates out-of-the-ordinary action outside the scope of regular politics. Securitization of uranium procurement has been taking place in India since the late 2000s, when the country established civil nuclear cooperation arrangements with it. The Indo-Kazakhstan uranium supply arrangements are being framed by political leaders and policy documents in an increasing sense as national security necessities that would be necessary to maintain the combat readiness of India nuclear power plants and to decrease reliance on troublesome suppliers. In practice, securitization has been in the form of

government-to-government contracts, long-term supply contracts with definite price components, and insulating uranium procurement against uncertainties of the open-market spot trading. Furthermore, securitization endorses exclusive diplomatic avenues where the negotiators of India can directly interact with the highest political leadership of Kazakhstan by bypassing exclusively based on commercial intermediaries.

Structural Power

The idea of structural power by Susan Strange (1994) leads to the shift of the analytical focus on direct bargaining to the capacity of an actor to influence the rules, frameworks and the contexts of operation within which others have to operate. Such structural power is given to Kazakhstan since it produces the majority of uranium in the world with over 40 percent of the world refining uranium. The influence is not realized by the unilateral political coercion but by the ability to shape the market, i.e. by establishing the desirable norms of contracts, establishing the minimum levels of quality and safety, and affecting the long-term trends of investment in uranium mining and processing. For India, structural power means that Kazakhstan can subtly dictate the terms of engagement, favouring buyers who offer political goodwill, upstream investment, or technology transfer. Without major Indian capital investment in the uranium industry of Kazakhstan, the bargaining power of New Delhi can hardly be described as an agenda-setting power, so it requires some practices to decrease the level of dependence, or rather to obtain an interest in the formation of market norms.

Complex Interdependence

Keohane and Nye (1973) complex interdependence model shows the multi-channel connections, including economic, diplomatic, technological and institutional factors that enmesh states into relationships of cooperation as well as competition. Indo-Kazakh nuclear collaboration is a reflection of such interdependence since it combines uranium supply, nuclear safety, research, and collaboration with multilateral organizations, including the International Atomic Energy Agency (IAEA). The association is however asymmetrically interdependent; the Republic of Kazakhstan is growingly diversified in the export portfolio and is providing uranium to other major nuclear powers of the world with China, Russia, France and Canada being among them. In India, in contrast, the range of suppliers that it is politically comfortable working with is smaller, and it is thus more

susceptible to any changes in the priorities of Kazakhstani export to India. Such an asymmetry implies that even though Kazakhstan sees India as a reliable long-term cooperation partner, Astana is capable of adjusting supply volumes with minor consequences in the country, yet without causing a major crisis of fuel supply to India.

Heartland Theory

The Heartland Theory of Halford Mackinder (2017), which was developed early in the 20th century, still remains relevant to analysis provided it is modified to address modern energy geopolitics. Kazakhstan lies in the heart of the "pivot area" of Eurasia that dominates the overland transport corridors between resource-rich interiors and the world markets. In nuclear power supply chain, this centricity promises an avenue of diversification beyond the ocean lines, e.g., the Strait of Malacca, which pose a risk to geopolitical destabilisation. In the case of India, the geographical position of Kazakhstan may present an opportunity to combine uranium supply chain with wider connectivity agenda such as the International North-South Transportation Corridor (INSTC) and trans-Caspian routes, respectively. This would lessen the reliance on the transport based off terrain secured by the opposing forces and boost strategic autonomy of India in energy transport. Moreover, being a transit and hub state, Kazakhstan is much more than a supplier of resources and is a key partner to India in developing its Eurasian engagement.

In Section 4.2, the geopolitical rivalry of the uranium industry around Kazakhstan will be plotted with the emphasis of the rivalry strategies of China, Russia, and other outside players in the field. Section 4.3 discusses the current state of India in such a competitive environment, evaluates the relative strengths and weaknesses of its strategy of differentiation based on trust and low capital investment. Institutional, legal and logistical restrictions are analyzed in section 4.4 and comprise liability systems and transit insecurity. A strategic discussion of the Indo-Kazakh partnership focused on strategic paths of deepening the Indo-Kazakh relationship up to integrated technology collaboration is shown in Section 4.5. These findings are synthesised and offer policy recommendations on protecting the Indian nuclear fuels security against market and geopolitical shocks in the concluding section. Overall, the provided introduction contextualizes the Indo-Kazakh nuclear alliance in another shifting uranium geopolitical environment by arguing that the pillars that were developed since 2011 have still survived, but the competitive environment has been altered, and the latter needs to be redefined strategically. Only when combining

its diplomatic, economic, and technological resources and bringing them into the structural reality of the market position and geopolitical environment in which India finds itself, can India be in a position to work on long-term energy security interests in the region. With the general background of the uranium industry in Kazakhstan and its role in the world established, the following section (4.2) will focus on the development of the India-Kazakhstan uranium relations with an attempt to trace the history of agreements, trade flows and overall course of relations which have led to the current relationship.

4.3 Application of Theoretical Framework to the Study

The nuclear involvement of India with Kazakhstan as described in this chapter is not as a bilateral energy relationship, but as a strategic engraving of response to the general energy vulnerability of India and its geopolitical location in Central Asia. Each of the theoretical perspectives can be applied to describe one more aspect of the study results and provide conceptual consistency to the analysis.

The dependency of India on the external flows of uranium has been theorized by application of the theory of Securitization wherein the dependency has been promoted as the national energy security issue. This continuous supply of uranium is not merely a business requirement as the uranium reserves in India are limited and its nuclear power ambitions are linked to the long-term clean energy and energy goals. It proves to be a tactical problem which concerns energy sovereignty, reactor perseverance and national development.

Structural Power helps me to understand why India was left in an unfavorable situation in the uranium business in Kazakhstan relative to other stakeholders such as China and Russia. Despite government-to-government uranium supply deals in India, China and Russia are more infrastructural, institutional, financially, and technologically represented in the region. This theory, therefore, enables the study to study the role of the power to control transport corridors, investment networks, enrichment plants and long-term institutional connections in determining access to the nuclear resources of Kazakhstan.

The cooperative yet asymmetrical nature of Indo-Kazakhstan nuclear relations is analysed with the aid of Complex Interdependence. There are commonalities between India and Kazakhstan: India needs a steady supply of uranium, and Kazakhstan needs new

export markets and alliances with countries outside of China and Russia. Nonetheless, this kind of relations is not equal since Kazakhstan has several strong partners, and the role of India is mainly focused on the acquisition of uranium, but not on its further investment, the transfer of technologies, or the establishment of joint production.

The Heartland Theory gives the geopolitical explanation of significance of Kazakhstan in the Central Asian policy of India. The geographic position of Kazakhstan, uranium resources, and multi-vector foreign policy positions it at the center of Indian aspirations to increase its presence in strategic, non-southern Asian, areas. In this light, Indian involvement with Kazakhstan is not merely on nuclear fuel security but it is also on the acquisition of diplomatic relevancy in an area influenced by the competition of the major powers.

Therefore, the theoretical framework allows a stratified understanding of the study. Securitization Theory describes the reasons behind the treatment of access to uranium as a strategic requirement; Structural Power describes why India continues to be weaker than China and Russia in the nuclear industry of Kazakhstan; Complex Interdependence describes the cooperative but asymmetrical character of the bilateral relationship; and Heartland Theory describes the greater geopolitical utility of Kazakhstan in the Eurasian energy strategy of India. The combination of these theories gives us the conceptual framework of the analysis of the current status of India, strategic constraints and future policy choices in the uranium industry of Kazakhstan.

4.4 Kazakhstan's Nuclear Sector: Strategic Landscape

Resource Endowment & Global Role

Kazakhstan holds an unparalleled position in the global uranium market, producing approximately 40% of the world's uranium output in 2023, a share that consolidates its status as the single largest supplier in the international nuclear fuel cycle (World Nuclear Association, 2025a). Its reserves of over 900,000 tonnes of recoverable uranium are vast, to say the least, and of high ore quality, which makes them especially appealing both in terms of short-term extraction and long-term production planning (Mining-Technology, 2024). Uranium industry of the country is a part of the wider nuclear fuel chain of the world. It is a supplier of raw uranium concentrate (U_3O_8) and is a supplier of

yellowcake (which it exports), and is gradually becoming involved in value-added activities, like fuel pellet fabrication, and nuclear technology services, in collaboration with foreign companies (International Atomic Energy Agency, 2023). The uranium produced in Kazakhstan is entrenched in supply chains to civil nuclear reactors in more than 12 countries such as major consumers in Europe, East Asia, and South Asia. This status has made Astana, not just a resource exporter, but a systemically significant participant in international nuclear governance. The large uranium mining activities in Kazakhstan are located in the southern and central parts of the country. Among the most important are Inkai, which is a joint venture with Canada, Cameco; South Inkai, which operates through partnerships with the Rosatom subsidiaries of Russia, and Irkol, an in-situ leach (ISL) mine, which is Japanese-invested; and Semizbay, which is a wholly owned asset run by Kazatomprom (Astana Times, 2024 Refining of the product is possible in processing facilities, including those in Stepnogorsk and Ulba, and in some instances, the production of fuel pellets. This combined industrial geography enables Kazakhstan to dominate key links in the uranium value chain, which would guarantee competitive pricing power and reliability to select partners.

Policy Orientation

Kazakhstan is highly influenced by its multivector foreign policy perspectives on approaching its uranium industry and the foreign policy attempts to negate excessive reliance on any individual partner, staying as balanced between China, Russia, the United States, the European Union, Japan, and India as possible (Vanderhill et al., 2020). In doing so, this approach enables Astana to take advantage of uranium diplomacy as both a trade and geopolitical instrument, opening to multiple bidders long-term supply contracts and using rivalries to win technology transfer, infrastructure investment and political goodwill. Recent events highlight the extent to which uranium production has been established as one strategy in the wider energy diplomacy of Kazakhstan. In recent years, the government has seriously sought rival bids by Russia Rosatom, China CNNC, South Korea KHNP, and France EDF to build the first nuclear power plant as part of its strategic policy of contingent diversification and maximising the bargaining power (Astana Times, 2025). It also enhances the credibility of Kazakhstan as a responsible nuclear supplier because Kazakhstan complies with International Atomic Energy Agency (IAEA) safeguards and is a signatory to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT). The fact that it

hosts the IAEA Low Enriched Uranium (LEU) Bank in Oskemen places the kingdom as a provider of nuclear fuel security in the world (International Atomic Energy Agency, 2023). Such institutional undertakings ensure that Kazakhstan is a low-risk partner in the aspect of compliance, particularly to those countries such as India that are under intense international observatory regimes.

Governance & Industrial Structure

The uranium industry in Kazakhstan is in turn controlled by the state-owned national atomic company Kazatomprom, which has a legal monopoly of uranium production, exploration, and export permits. Established in 1997, Kazatomprom has transitioned over the years into an uprightly integrated corporation with shareholding options extending across the world and on stock indexes, as well. It has been partially privatised into being the Astana International Exchange which deals with stocks and the London Stock exchange which has made it more open and to foreign investment, but not losing state control as the last party (Kazatomprom, 2024). This industrial model of the company is based on the concept of joint venture, which provides foreign companies with an opportunity to obtain equity interests in a particular mine but Kazatomprom owns the majority. This has been drawing attention of Cameco (Canada), Orano (France), China General Nuclear (CGN) and Japanese conglomerates, who are not only investors, but also provide technical expertise and market accessibility, besides finance (Kazatomprom, 2025). Equity distribution of Kazatomprom is an expression of a prudent strike of state interest, foreign capital and strategic partnership considerations. Although the state has a majority ownership of over 75 per cent of this controlled under the Sovereign Wealth Fund Samruk-Kazyna, the minority stakes are provided by the strategic joint ventures that are usually 30-49 per cent to foreign partners in order to achieve mutual interest in the investment and maintain national authority on the resource policy. The company 2023 financial performance reflected its endurance against the slight decline in production, due to the minor market price optimisation strategies as opposed to the factors of constraint to production (Trend News Agency, 2024).

Geopolitical Stakes

Kazakhstan’s uranium is strategically irreplaceable for several reasons. First, its size and consistency have made it one of the few suppliers who would be able to fulfill big, long-

term orders with minimal supply risks. Second, it is more politically stable, compared to other uranium producers such as Niger or Uzbekistan, which reduces geopolitical risk premiums to purchasers. Third, the embeddedness of Kazakhstan in global governance systems implies that its supply is not as vulnerable to sanctions or trade embargo in the existing geopolitical alignments (World Nuclear News, 2025a). In the case of India, Kazakhstan has been heightened by the geopolitical rivalry over the availability of uranium. China has further increased its equity control in several Kazakh mines and is incorporating in its state owned nuclear conglomerates. Russia still has a historical and a joint venture (JV) interest, and Western utilities are interested in establishing long-term contracts, hoping to have a stricter global supply after the war in Ukraine. It is on this background that India has to be a player in a dense strategic environment where great-power politics are entangled with competition in the market. The history of uranium industry in Kazakhstan depicts how this country has evolved to become the world leader as indicated in Table 4.1.

Table 4.1: Evolution of Kazakhstan's Uranium Sector (1991–2025)

Period	Key Developments
1991–1997	Post-independence restructuring, with Soviet-era mines remaining under state control; production volumes collapse due to economic transition.
1997–2005	Formation of Kazatomprom and adoption of in-situ leach (ISL)technology, leading to steady production recovery.
2006–2010	Rapid expansion through joint ventures with foreign investors; Kazakhstan surpasses Canada and Australia to become the leading uranium producer.
2011–2015	Stabilisation of high production levels; integration into international nuclear governance mechanisms.
2016–2019	Partial privatisation of Kazatomprom; production output optimized to align with global market demand.
2020–2022	COVID-19-induced disruptions followed by recovery; marked increase in Chinese equity investments in uranium projects.
2023–2025	Strategic recalibration in response to geopolitical turbulence; emphasis on vertical integration and value-added uranium exports.

Sources: *Astana Times. (2024).*

This development is indicative of a long-term policy of limited liberalisation, state monopoly with openness to foreign collaboration, and supports the explanation of why Kazakhstan has become an essential element in the world fuel chains of nuclear fuel. Having laid the groundwork of bilateral uranium collaboration in history, section 4.3 will proceed to conduct a critical evaluation of geo-political dynamics that will define the Indian involvement in the Kazakhstan context with a focus on how power balance within the region impacts access and negotiation results.

4.5 External Powers' Engagement Models in Kazakhstan

China - Equity-Driven Strategic Entrenchment

Chinese investment in the Kazakhstan uranium business is rather an equity policy whereby it aims at controlling the mine and not necessarily purchasing the supply contracts. Two large state-owned companies through which Beijing has attempted to establish joint ventures through which the former company is granted considerable ownership rights to some of the most fruitful deposits in Kazakhstan are China General Nuclear Power Group (CGN) and China National Nuclear Corporation (CNNC) (World Nuclear News, 2025b). Not only does this type of ownership structure secure long-term supply, but it also allows China to control the production timeline and export quotas to meet its nuclear energy development, en plans domestically. According to the Carnegie Endowment of international peace (2024), Kazakhstan has had to enlist local partners to the Chinese entities to reduce the level of foreign domination, a fact that has led to a complex equity framework whereby Kazatomprom remains the majority shareholder, although CGN and CNNC have gained operational bargaining power. These plans go beyond mine-level operations to infrastructure integration especially under the Belt and Road Initiative (BRI). Over land movement of uranium concentrate is achieved via transport corridors like the Western Europe-Western China highway and the Khorgos dry port, which makes Beijing more effective in avoiding maritime chokepoints (MiningSee, 2024).

The contracts that China has with Kazakhstan are usually of long durations (10-20 years) and usually include exclusivity agreements, which cannot be resold to third parties. Although this will provide stability to both the supplier and buyer, it will limit the flexibility of the exporting capacity of Kazakhstan effectively isolating some of its output

to be absorbed by the Chinese. This position gives Beijing price power over other purchasers as it may control the percentage of Kazakh uranium on the spot. Nevertheless, the policy of China has its limitations. As Intellinews (2024) points out, Beijing is also over-invested in various BRI-related energy projects, both in CPEC in Pakistan and in African resource projects. Such a scattering of both financial and political capital can constrain its capacity to increase its equity investments in Kazakhstan without burdening its global portfolio.

Russia - Legacy Integration & Enrichment Dominance

The Soviet-era infrastructure has embedded the Russian control in the nuclear industry of Kazakhstan. A significant part of the uranium reserves in Kazakhstan was initially charted, prepared, and incorporated into the Soviet nuclear system, and logistical and processing connections to Russian land (Eurasia Daily Monitor, 2025). This legacy, post-independence, manifested as the Russian continued hegemony in some phases of the nuclear fuel cycle, such as uranium enrichment and fuel fabrication, where Rosatom has a technological and infrastructural edge. Rosatom is not only involved in the mining business but also the construction of nuclear power plants. Moscow has since been contracted to construct the first nuclear power station in Kazakhstan, after a countrywide referendum in which most citizens voted in favour of it (The Moscow Times, 2025; Reuters, 2024). The project which is projected to be situated close to the lake Balkhash will entangle civil nuclear infrastructure of Kazakhstan more to Russian technology and standards of operation. Kazakhstan continues to be reliant on Russian transit routes to export some of its uranium to Europe via rail, which links to Baltic and Black sea ports. Such dependence provides the Moscow with a latent veto over the uranium flows of Kazakhstan to the west, especially in a situation of increased geopolitical tension.

The Eurasian Economic Union (EAEU) where Kazakhstan is a member alongside Russia also provides a regulatory framework that affects the cross-border trade in uranium. Although, in theory, the EAEU is aimed at helping to move goods freely, it can also be used politically since, in certain aspects, Moscow holds the dominant position in establishing regulatory standards. However, the stance of Russia is limited. The sanctions imposed on Ukraine have limited Western collaboration with Rosatom and the appeal of Russian-related supply chains to certain customers (The Diplomat, 2024). Although Moscow still enjoys firm bases in the capital of Kazakhstan, it will be possible to

determine the sustainability of these connections based on its ability to shield nuclear relations with the wider array of sanction policies.

Western Powers - Diversification without Deep Roots

With the United States, Europe, Japan, and South Korea being the main western players in the uranium industry, the desire to involve themselves in the uranium industry of Kazakhstan can be explained by the strategic need to reduce dependency on Russian fuel (Bruegel, 2025). As an example, the EU has publicly pledged to stop importing Russian uranium, and utilities and fuel cycle firms have been looking to find new sources, which Kazakhstan is an obvious substitute (Intellinews, 2024). The US policy is a mix of strategic reserve and spot market purchases which leaves flexibility but leaves minimal assurances to Kazakhstan regarding long-term demand. The EU, in turn, has been more assertive in brokering medium-term supply deals, but these tend to be smaller than those of China or Russia. Japan and South Korea have undertaken technology partnerships as opposed to massive equity investment with emphasis on fuel processing, reactor parts and nuclear safety training. Such partnerships boost the technical capabilities of Kazakhstan but fail to entrench foreign ownership of the mines. In this way, even though they help to diversify the partnership of Kazakhstan, they do not have the structural entrenchment as in the case of Chinese and Russian.

The most important limitation that the Western powers have is the fact that they have a small physical presence in Central Asia. The geographic distance, lack of overland transportation routes under their control, and the established status of Russia and China are all barriers to more intense engagement. Additionally, entry barriers tend to be more pronounced in the case of Western investors as the policies of joint ventures in Kazakhstan are more inclined to find partners who provide capital and the ability to fit the geopolitical environment. On the geopolitical terrain, section 4.4 will further reduce to the present India in Kazakhstan and indicate the type of contracts, the volume of trade, strengths, and weaknesses of the country compared with other key players.

4.6 India's Current Position in Kazakhstan

The involvement of India in the uranium business with Kazakhstan can be traced back to more than ten years of well-organized, government-to-government (G2G) deals

that have provided it with a stable, albeit a small, uranium supply path to its nuclear power programme. The relationship indicates a combination of political goodwill, normative convergence on nuclear non-proliferation and a cooperative diplomatic tone. Nevertheless, India has not become a strategic stakeholder, but a contractual one, which creates openings in structural influence on the uranium supply chain of Kazakhstan.

Nature of Engagement: Government-to-Government Contracts

Since the initial uranium supply deal was signed in 2009 and initial deliveries of natural uranium commenced in 2011, India has had continuous contractual relations with Kazakhstan in relation to natural uranium concentrates. Such agreements are negotiated on the top level between the Government of India Department of Atomic Energy (DAE) and the Kazakhstan state-owned Kazatomprom the largest uranium producer in the world (World Nuclear Association, 2025a). These contracts are usually three to five-year contracts, providing certainty in the supply volumes without any speculative exposure to the spot-market. This G2G format signifies the trust-based essence of bilateral relations, which supports the image of India as a non-threatening and trustworthy partner to Kazakhstan (Chaudhury, 2023).

Quantitative Trend: Import Volumes and Market Share

The uranium imports by India in Kazakhstan have been significantly consistent even in the times when the global supply chain was facing disruption. The Government of India, according to its DAE (2025) parliamentary records, has continued to be the largest single country supplier of natural uranium to India, with between 35% and 55% of its total imports in the last decade. This steadiness is in contrast to the more unstable shares of suppliers such as Canada or Uzbekistan which are subject to changes in market relations and diplomatic issues. Table 4.2 below shows the uranium imports of India in the years 2011 to 2024 of Kazakhstan, which shows the absolute level of imports and the percentage composition in the overall basket of uranium imports in India.

Table 4.2: India's Uranium Imports from Kazakhstan (2011-2024) - Volumes and Share in Total Imports

Year	Uranium Imports from Kazakhstan (tU)	% Share of India's Total Uranium Imports
2011	300	35%
2014	500	45%
2017	650	50%
2020	700	55%
2022	620	48%
2024	680	50%

Source: *Parliamentary reply by Department of Atomic Energy, Government of India (2025).*

Strengths of the Current Engagement

The uranium partnership between India and Kazakhstan is based on some strong points. First, there is the political goodwill that has been built by frequent high-level visits, joint commissions, and conformity to non-proliferation standards under the umbrella of the International Atomic Energy Agency (IAEA) (World Nuclear News, 2022c). Kazakhstan perceives India as a win-win situation, as it understands that India has an increasing energy demand, and it can be used to diversify the export base of Kazakhstan (Chaudhury, 2023). The other strength is the diplomatic stance of India as a peaceful nuclear power, which is opposite to the aggressive approaches of China and Russia. Such perception eases negotiations that are based on trust and makes renewal of contracts without significant political tension.

Weaknesses and Strategic Gaps

Although India has these strengths, the structural weaknesses limit its position. It does not have any equity in the Kazakh uranium mines and processing facilities, thus restricting its control over production decisions, cost structure, and export priorities (Economic Times, 2019). Moreover, the transportation of uranium is closely linked to the International North-South Transport Corridor (INSTC) and the Chabahar route, which implies the involvement of several transit states and possible geopolitical bottlenecks. The

pace of bilateral cooperation has also been sometimes hindered by institutional delays in renewing contracts, caused by domestic procurement procedures and regulatory approvals (World Nuclear Association, 2025b). These constraints undermine the bargaining power of India relative to other actors such as China who combine mining equity, transport infrastructure and political leverage into one strategic bundle.

Theoretical Linkages: Complex Interdependence and Structural Power

The uranium trade between India and Kazakhstan can be explained through the concept of complex interdependence developed by Keohane and Nye (1973) wherein the relationship is furthered by mutual trust and common interests and is not by coercion. Nevertheless, the theory of structural power by Susan Strange (1994) puts the limitation of the current strategy of India into the limelight. India cannot influence the rules of the game in the uranium market without upstream equity in production or control of the logistics. This asymmetry implies that Kazakhstan has the ability to re-export to higher paying or more strategically oriented partners and India is left as a price-taker with very little strategic flexibility.

Overall, India's current position in Kazakhstan's uranium sector is one of high political goodwill but limited structural influence. Although G2G contracts have provided long-term and reliable supply of uranium over the past ten years, lack of equity interests, dependence on insecure transport routes, and delays in the procedures limit the capacity of India to establish long-term and resilient supply chains. To close this gap, there will be a need to change the model of engagement based on trust with transactional diplomacy to the diversified engagement model that will encompass investment, technology, and infrastructure. After examining the current position of India, section 4.5 will use systematic analytical instruments, such as a comparative actor framework and a SWOT analysis, to analytically examine India competitive advantages, vulnerabilities and strategic opportunities in the Kazakh uranium market.

The current situation of India in Kazakhstan is a pointer of an asymmetrical relationship but that of cooperation. Based on the perspective of Complex Interdependence, India and Kazakhstan are both winners of the existing nuclear relationship: India can use uranium resources and Kazakhstan can diversify export trade and foreign relations. However, even this interdependence remains minuscule with the role of India remaining

more as a government-to-government procurement of uranium, than as an equity partner, technology partner, or institutional partner. Structural Powerwise, India has not yet reached the same level of influence as China or Russia to entrench themselves better in the nuclear sector of Kazakhstan with more infrastructural, financial, and strategic links. This status quo of India can, therefore, be said to be strategically relevant but structurally constrained.

4.7 Comparative Analysis - India vs. External Actors

Comparative Table of Engagement Models

Indian approach to Participation in Kazakhstan uranium industry is radically unlike India position of the rest of the most important players such as China, Russia and Western world. Since India has been keen on long-term supply deals to count on resting on its development strategic partnership arrangement (Singh, 2015; Pradhan, 2022), competitors have targeted a deeper format taking into account the resources ownership, infrastructure integration, and political sway. This is in accordance with the domestic resource sector dynamics that could be analyzed throughout Central Asia where the energy and mineral market approach is becoming interdependent with the local shift and economic changes (Smagulova et al., 2025). A comparative view is given in table 4.3 below.

Table 4.3: Engagement Models in Kazakhstan's Uranium Sector: India and External Actors (2025)

Actor	Engagement Mode	Supply Chain Control	Political Leverage	Sustainability of Presence	References
India	Long-term supply contracts, no equity stake, focus on diplomatic channels	Limited, dependent on Kazakh production and logistics	Moderate, framed within Strategic Partnership & multilateral forums	Vulnerable to market competition; depends on renewals	Singh (2015b); Pradhan (2022)

China	Mine-level equity (CGN, CNNC), integrated with Belt and Road corridors	High, controls extraction, transport, and part of the export allocation	High, combines resource security with infrastructure dominance	Strong, secured 15-20-year contracts	Carnegie Endowment (2024); MiningSee (2024)
Russia	Legacy integration through Rosatom, control over enrichment	High, controls processing and transit	High institutional leverage via EAEU	Moderate, sanctions impact Western collaboration	Eurasia Daily Monitor (2025); Siddi & Silvan (2023)
Western Powers	Diversification via spot/ medium-term contracts, tech partnerships	Low, no major equity stake or logistics control	Moderate, policy influence through trade diversification	Limited, reliant on competitive bidding	Bruegel (2025); Shannak et al. (2025)

This analogy highlights how India is in a weaker place diplomatically friendly, but it does not have the economic and logistical footprint that China and Russia have. Without the control of equity, India is at a disadvantage to changes in the export policy and competition in the tightening global uranium market in Kazakhstan (Shannak et al., 2025).

The comparative study reveals that the engagement model of India is very different in contrast to China and Russia. By relying more on the supply agreements and the goodwill of diplomacy, India has been able to gain more influence due to the assistance of equity investments and infrastructure financing and long-term resource-related agreements made with China. Russia though has structural advantages attributed to historical relationships, enrichment capabilities, nuclear technology network and institutional continuity. This echoes the rationality of Structural Power in which power is influenced not only by access to resources but also by power over the broader mechanisms of production, technology, finance and logistics. In this regard, the weaker structural position of India justifies the reason why the Indian interaction with Kazakhstan is of relevance but less

entrenched compared to their key competitors.

SWOT Analysis for India in the Kazakh Uranium Market

A SWOT (Strengths, Weaknesses, Opportunities, and Threats) framework will serve as an analytical presenting format to review the current and the favorite role India could play in the development of the uranium industry in Kazakhstan. This method enables the systematization of internal capabilities, positive (strengths) and limiting (weaknesses), as well as external situations that can be used (opportunities), which should be reduced (threats) (Elavarasan et al., 2020). The rationale behind the use of SWOT herein is to guide the strategic undertakings such that Indian policymakers, energy planners, and foreign policy players will be in a position to improve the engagement process, minimise areas of weakness and maximise gains that can be reaped on a long-term basis by the bilateral cooperation. The examination also brings to light the comparison between the role of India in Kazakhstan amidst other key players, namely China and Russia and how increased proactive action should be taken in the narrowing and geopolitically conscious uranium market.

Strengths: The ability to maintain an established diplomatic capital with Kazakhstan on the back of the 2009 Joint Declaration on Strategic Partnership and in the mechanism of supported rounds of bilateral agreements has been the key strength of India. These structures have developed a steadier, trust-comes-first political interaction that enables mutual understanding of cooperation in sensitive areas like nuclear energy (Joint Declaration on Strategic Partnership between India and Kazakhstan, 2009) Moreover, India has a clean non-proliferation history and works under the International Atomic Energy Agency (IAEA) safeguards, which makes itself a more credible nuclear energy partner. This normative convergence serves to be in the favor of India with Kazakhstan as the latter wants to establish steady and globally acceptable export relations (Kassenova, 2010). Political goodwill and respect to the global nuclear governance rules and regulations have made India a reliable player in the sale of uranium.

Weaknesses: India is structurally restricted in the uranium industry in Kazakhstan despite its good diplomatic positioning. However, importantly, it does not actually have direct equity interests in any uranium mining or processing operations which has

limited its scope to affect operational choices, production schedule, and export distributions. There is a lack of upstream influence and as such India is more of a price-taker as opposed to a price-maker. Besides, the uranium supply chain between India and Kazakhstan is highly vulnerable to a monopoly source, further prone to geopolitical shocks or export policies or the logistical issues which occurs depending on the takes over the multiplication of India and Kazakhstan (Li et al., 2021). Moreover, the predictability of supply can be disrupted due to institutional delays in renewing the contracts, which ensures India to be more restrained.

Opportunities: India has given strategic opportunities to supply chains of nuclear energy all over the world, at a time of overlaps in restructuring. Geopolitical tensions that serve to exacerbate the diversification process of western leaders out of Russian nuclear fuel sources present India with an opportunity to increase its share in the uranium export sector in Kazakhstan. Kazakhstan being a conglomerate uranium producer perfectly fits in to service this diversification and India can position itself in such a way that they can enjoy a bigger more flexible longer term uranium supply contracts. In addition to purchasing the fuel, India can look into the possibility of intermingling the trade of uranium with wider connectivity projects in Central Asia including transport corridors and other energy infrastructure projects. Such projects have the potential to strengthen the economic interdependence and generate synergetic advantages apparent even outside the nuclear field (Pradhan, 2022).

Threats: The presence of India in the Kazakhstani uranium market is becoming increasingly threatened by the growing competition that is being posed by other key players in the industry especially China. The Chinese state-owned firms have gained valuable equity positions in various Kazakhstan uranium projects and are allowed privileged access to Kazakh uranium production during the entire processing of uranium-related trade. This established position threatens to push India out of flexible allocation of supply. Also there is volatility in the world price of uranium due to speculation in the market, changes in energy demand and geopolitical events which put a risk on the stability of long term contracts. The increased participation of new consumers of nuclear energy into the market also makes the market competitive, which might restrict the negotiating space of India and escalate the cost of procurement (Shannak et al., 2025).

Overall, the relationship of India in Kazakhstan's uranium can be explained by good diplomatic goodwill and normative reliability, but cannot be hidden in structural restrictions that bind India with ownership and supply chain diversification. The new potential that was created in the international uranium market, especially by the changes in geopolitical allegiances, can be utilized to gain a greater advantage on behalf of India. Nonetheless, unless India proactively invests, enters the nuclear value chain of Kazakhstan more closely, and protects itself against the detrimental impacts of external competition, it faces the risk of isolation in one of the sectors that it cannot afford to ignore in its long-term energy security. Table 4.4 provides a brief SWOT matrix that describes the strengths, weaknesses, opportunities, and threats in the Indian Uranium industry in Kazakhstan that relate to issues of diplomatic advantage, market opportunity, structural limitation, and external competitive force.

Table 4.4: SWOT Matrix: India in the Kazakh Uranium Market

Strengths	**Weaknesses**
Established high-level diplomatic engagement since 2009, with a stable political rapport in the nuclear sector.	No direct ownership or equity in Kazakh uranium mining or processing operations.
Recognized by the IAEA for a consistent, responsible non-proliferation record.	Heavy dependence on Kazakhstan as a single-source supplier for uranium imports.
Viewed as a politically non-threatening partner compared to some major powers.	Vulnerable to logistical bottlenecks via complex transport corridors (INSTC, Chabahar).
Positive normative alignment with international nuclear governance norms.	Delays in contract renewal processes reduce supply certainty.
Opportunities	**Threats**
Global trend to diversify away from Russian nuclear fuel creates new procurement space.	China’s deep equity integration in Kazakh uranium projects could limit India’s access.
Potential to expand long-term supply contracts with flexible delivery terms.	Price volatility in global uranium markets could destabilise contract economics.

Scope to integrate uranium trade with broader Central Asia connectivity and infrastructure initiatives.	The entry of new nuclear energy consumers increases competition for supply.
Growing global emphasis on clean energy transition strengthens nuclear energy demand.	Possible shifts in Kazakh export policy are influenced by competing strategic partners.

Opportunity Cost of Avoiding Equity Investment

Refraining from equity investment in uranium mines of Kazakhstan deprives India of structural influence and a cross-secured supply of uranium in the long run. According to structural power theory (Strange, 1994), having control over the ability to produce as opposed to being able to have access to markets is equally important. In the absence of equity stakes, India has no voice over production quotas, export allocation, or pricing, and has to rely on the goodwill of suppliers and is vulnerable to tides in geopolitical alignment. For example, a hypothetical 10-15% equity position in a mid-tier Kazakh mine could secure India an additional 1,000-1,500 tonnes of uranium annually, insulating it from market volatility (Shannak et al., 2025). Conversely, with the current model, India would be outbidded by other competitors in case of supply squeeze, particularly in a post-Ukraine war situation where Western nations are frantically trying to find non-Russian sources of uranium. The opportunity cost is also not purely financial but strategic as in the sense that it restricts the ability of India to make nuclear energy more diverse and have uninterrupted supply of reactor fuel.

Theoretical Insights: Structural Power and Complex Interdependence

The relations of India and the uranium industry in Kazakhstan can be successfully examined in terms of asymmetry in the structural power and the interdependence of the relations. Structurally speaking, China and Russia have established dominance, which dictates production, distribution, and access to markets in the nuclear value chain of Kazakhstan (Siddi & Silvan, 2023). Their equity interest, control of infrastructure and long-term strategic presence enables them to set the norms and gain preferential access, whereas India is largely a price taker with little control over operational or logistical decisions. This asymmetry highlights the fact that India has a weak bargaining power and

relies on the consistency of bilateral deals. According to the perspective of complex interdependence, as expressed by Keohane and Nye (1973), the India-Kazakhstan relationship is asymmetric by its nature: Kazakhstan can comparatively easily shift away uranium exports to other customers, whereas India has to incur high replacement costs and with limited supply options. This increased vulnerability supports the strategic need that India must rebrand the pillars of its involvement by guaranteeing ownership of assets, forging joint ventures and making itself more in-depth within the uranium production and supply chain of Kazakhstan. Based on this systematic analysis, section 4.6 will examine how Kazakhstan uranium market trends will impact Indian energy security, including short, medium, and long-term risks and predicting possible outcomes in terms of supply stability.

4.8 Implications for India's Energy Security

The implications of the India role in the uranium industry of Kazakhstan can be applied to the Securitization Theory since the access to uranium is not an energy trade issue but it is a strategic requirement of national energy security. The Indian nuclear development projects, clean energy objectives and long-term operation of reactors are all dependent on the availability of uranium. The effect of a crisis in the supply of uranium in Kazakhstan on India could therefore not only affect the energy planning but also developmental and strategic interests of India as a whole. This securitized conception is what makes Kazakhstan a prominent part of the Indian energy diplomacy and the stability of such a partnership a strategic issue.

Indian strategic involvement in the uranium industry of Kazakhstan is a key to its energy security strategy. Nevertheless, the changing geopolitical nature, market competition, and domestic energy aspirations of Kazakhstan all render overlapping risks, which are compounded by the timeframes of short-, medium-, and long-term. Such risks are highly necessary in assessing future vulnerabilities and developing counter-strategies that would effectively mitigate the impacts on the supply security of India.

Short-Term Risks: Contract Competition and Maritime Route Vulnerability

On a short-term scale, India will be under increased pressure in its uranium contract acquisitions because of the competitive acquisition tactics of China, Russia, and other

Western countries wishing to diversify fuel away from Russian fuel. India has hardly any equity in the mines of Kazakhstan, and therefore is on fixed-term contracts, which they can renegotiate or turn around to other players who can pay a better price, quicker logistics, or work out political favours. Further, the production of the uranium that Kazakhstan exports to various parts of the world is usually transferred through maritime transportation that can be disrupted due to geopolitical problems, risk of piracy, and an increase in transport time, especially where transport centers in Russia or the Caspian Sea region are destabilized. Disruptions of any chokepoints would cause delays in supply and affect reactor fuel schedules in Indian nuclear power plants.

Medium-Term Risks: Prioritisation of China and Russia in Kazakh Exports

In the next five to seven years, the emphasis in the export profile of uranium in Kazakhstan can become more oriented towards China and Russia, according to the current equalities in partner companies, long-term supply contracts, and integration infrastructures. The Belt and Road related transport routes that China is linked to and the legacy control of Russia through awaiting enrichment facilities are structural opportunities that both countries possess at present that India does not. In future allocation decisions, Kazakhstan may want to give prominence to such partners, which would decrease the portion of India in the number of available exports, compelling it to depend on leaner suppliers in Africa or Canada, where the prices and lead time are much more expensive. This would not only impact on competitiveness of prices but also lower flexibility in achieving domestic nuclear energy extension outcomes.

Long-Term Risks: Domestic Use Expansion and Multisector Policy Shifts

Two structural changes are possible, which could become long-term important sources of threat to access to uranium for India. First, the nuclear energy program in Kazakhstan is waiting to grow, with the project of the first nuclear power plant and potential subsequent disclosure. Greater internal demand would reduce the amount of merchandise to be placed on the international market; this renders a tighter supply in the international market. Second, the balanced multi-vector foreign policy that Kazakhstan has pursued could also equilibrate on strain in the case of applied geopolitical tension. An example here would be under intense strategic convergence, either with China or Russia, compelled by either security or economic reasons, which might reduce the gap here to

connecting independently with India. It would drain the diplomatic reserves of goodwill nurtured on bilateral cooperation spanning decades and lower the bargaining power of India.

Scenario Assessment: India's Uranium Access

The future access of India to Kazakh uranium will be influenced by a powerful interaction between the market forces, geopolitical calculations, as well as the development of bilateral collaboration. The fluctuating nature of uranium prices worldwide, changes in the priorities of the export strategy of Kazakhstan, and the level of India becoming participation in the upstream value chain would all define the stability and affordability of the supplies. In the most desirable circumstances, India would be able to enjoy stable prices, a balanced Kazakhstani export policy, and gradual and continual investments in mining and processing projects. With such an environment, predictable supplies at competitive rates would prevail, and it would also greatly increase the bargaining leverage enjoyed by India when it comes to the negotiation of contracts. Such attainment could, however, be achieved through long-term political participation, involvement of more companies in joint ventures, as well as the diversification of the logistics channels in a bid to cut overreliance on one transport corridor.

In a slightly less severe base case, competition against other leading consumers, especially China and Russia, would be sustainable, although some price surge may upset procurement plans periodically. In this instance, the uranium sources in India could also be relatively stable, even though they are susceptible to the changes of market sentiment or contract renegotiation. The lack of large Indian equity investment would persist as a hindrance to strategic control and partial upstream investments or multi-year supply contracts, or grad if incremental strategic reserves should be built to hold off unexpected jolts. Under the worst-case scenario, a definitive geopolitical shift by Kazakhstan to either China or Russia, and increasing demand in Kazakhstan, could seriously reduce exports to India. This would not only lead to an augmentation in procurement expenses, but also jeopardize India's ability to carry out the nuclear expansion plans on time. To address these risks, India would have to rapidly diversify their sources of supply, resorting to Africa, Canada, and other parts with high repositories of uranium, even as it made a step forward in increasing the pace of explorations in its borders and diplomatic charters in ensuring that it does not lose its position in the Kazakhstan export agenda. The three scenarios and their

core implications are summarised below in Table 4.5.

Table 4.5: Projected Scenarios for India's Uranium Access from Kazakhstan

Scenario	Likely Outcome for India	Core Policy Imperatives
Best Case	Stable supplies at competitive prices, improved negotiating position.	Deepen joint ventures, expand logistics routes, and maintain strong political ties.
Baseline	Generally steady supply, but exposure to price spikes and renegotiations.	Secure multi-year contracts, invest in partial equity, build strategic reserves.
Worst Case	Severe supply reduction, cost escalation, and delayed nuclear projects.	Diversify sourcing to Africa/Canada, accelerate domestic mining, and apply diplomatic pressure.

These scenarios highlight the fact that the future of India in terms of uranium security by Kazakhstan will not only be determined by the external market and geopolitical factors but also how far New Delhi will go in terms of strategic equity, logistical resilience and diplomatic leverage. The actions that are being proactively implemented now, especially in enhancing the economic integration and the acquisition of diverse transport corridors, will have a huge impact on whether India will undergo the best or worst pathway in the next ten years. Having mapped the risk landscape, section 4.7 will suggest a list of strategic paths in the economic, technological, diplomatic, and infrastructure domains to redefine the pillars of engagement in India to ensure access to uranium in the long term and enhance bilateral cooperation.

4.9 Strategic Pathways - Recasting the Pillars

India-Kazakhstan co-operation in the uranium industry should be developed as a multidimensional strategic partnership in the area and not on delivery-based supply agreements. The evolving world of nuclear politics and the growing interest of outside influences like China and Russia in the nuclear situation requires a changed policy. Four interdependent pillars can be constructed to form a long-term sustainable energy security framework, comprising economic and investment cooperation, technological collaboration,

diplomatic engagement, and infrastructure development, which are aimed at resolving the current unaddressed vulnerabilities and improving the bargaining power of India.

Economic & Investment Pillar

Lack of equity participation in the uranium mining sector in Kazakhstan is one of the most serious shortcomings of the current strategy of India. The purchasing of minority equity in key mines, even to a level of 10-25% will bring India a proportional off-take contract. This will ensure that India has a voice in operational and policy decisions. As prior experience with other actors, as stated in Kazatomprom annual reports (2018-2024) by SC National Atomic Company Kazatomprom reveals, equity-linked arrangements are much more resilient in times of market volatility in contrast to purely contractual deals. Moreover, co-financing uranium conversion and fabrication facilities in Kazakhstan can allow India to become a part of the larger nuclear fuel cycle, easing its access to foreign conversion facilities. Even these investments would be complemented by price-indexed, volume-flexible long-term contracts, which would stabilize supply but enable adjustment to market terms, which are already widely used in the LNG market and can readily be adapted in purchasing uranium.

Technological Cooperation Pillar

Technological cooperation gives India a chance to strategically strengthen its interdependence with Kazakhstan. The possible opportunity is co-development of Small Modular Reactors (SMRs) one of them would be situated in Kazakhstan. Not only would such a project provide India with a platform on which to demonstrate its nuclear capabilities but it would also enable Kazakhstan to diversify its domestic energy supply on nuclear power generation. Moreover, the joint research and development initiatives (R&D) in advanced fuel cycles, such as thorium-based ones and nuclear waste vitrification can create the mutual intellectual property and address similar-minded environmental concerns. To achieve this cooperation, it is necessary to harmonise the regulatory framework between the nuclear authorities of Kazakhstan and the Atomic Energy Regulatory Board (AERB) of India. This type of synchronization would smooth out licensing, safety and technical compliance, and lead to lagging of shared projects being reduced and investor confidence being enhanced.

Diplomatic & Multilateral Pillar

Diplomacy forms the core of long-term involvement in such a geopolitically important industry as nuclear power. The institutionalisation of an Indian-Kazakhstan Nuclear Cooperation Council would institutionalise bilateral dialogue so that responses to policy, investment, and crisis management could be coordinated regularly. India, in its multilateral capacity, should take full advantage of the available tools in the form of the Shanghai Cooperation Organisation (SCO), BRICS-International Atomic Energy Agency (IAEA) to influence the norms in the uranium markets and protect the interests of non-equity buyers. It could also manage an additional cushion with the IAEA Low Enriched Uranium (LEU) Bank in Kazakhstan (IAEA) in the event of a breakdown in the market. In addition to bilateral and multilateral cooperation, India could find triangular cooperation partners, i.e., with technologically advanced third parties like Japan or the UAE. These alliances would pool the resources, share the risk, and diversify their influence in the nuclear sector of Kazakhstan to counter the established role of China and Russia.

Infrastructure & Logistics Pillar

Indian uranium imports from Kazakhstan are also subject to the firm reliability and security of logistics in the long term. Russian routes are strategically vulnerable, as much of the uranium transit concerns them as it currently stands. Another opportunity is the development of the so-called Middle Corridor trade route through the Caspian Sea, Azerbaijan, Georgia, and Turkey, which would allow avoiding Russian soil. India could take part in the financing and operational management levels of this corridor to ensure more robust supply chains. By establishing bonded logistic hubs in Kazakhstan or adjacent countries, India can forward the uranium and be able to store and stage it in the facility where deliveries are to be made on time, and can avoid the single route transit. In addition to this, India needs to build up its own strategic uranium stocks to a large extent. As indicated in the parliamentary statement of the Government of India, Department of Atomic Energy 2025, the stockpile of at least two years' worth of the reactor supply would mitigate the effects of a supply shock and market fluctuations critical to a breakthrough.

Integrating the Four Pillars into a Unified Strategy

Although the four pillars have their own benefits, they will be most useful when combined

into a single strategic framework. The changes of geopolitical orientation might destabilize economic investments without diplomatic protection, and technological collaboration without effective logistics might be disrupted by delivery problems. The Integrated India-Kazakhstan Nuclear Engagement Plan needs to be formulated accordingly that clearly ties the equity investments, technology transfer, institutionalisation of diplomatic institutions and infrastructural projects in the same governance framework. This comprehensive solution would allow India to become not a passive, contract-dependent buyer but an active co-architect of the nuclear future of Kazakhstan, which would reduce structural weaknesses and increase its long-term energy security.

India's engagement with Kazakhstan in the uranium sector, assessing historical trade patterns, strengths and weaknesses, theoretical underpinnings, and the strategic implications for energy security, has been discussed in this chapter. It has also presented future scenarios of India access to uranium given different geopolitical and market environments. Chapter 5 will follow up these findings by placing the Kazakhstan case in the context of external nuclear fuel ties that India has with other countries. It will generalise the learning across all the chapters that have been developed to respond to the general research questions, to point out the cross cutting challenges and the proposed integrated policy measures to enhance the long term energy security of India.

Heartland Theory and Complex Interdependence are also faced with some relevancy in the proposed strategic paths. Kazakhstan is strategically located to the long-term Indian presence in Central Asia, particularly with connectivity projects such as the International North-South Transport Corridor and Chabahar Port, as it commands the geopolitical center of Eurasia. Economic, technological, diplomatic and logistical pillars would be improved to allow India to forget its old buyer-supplier dynamic and establish a more sustainable form of interdependence with Kazakhstan. Regarding Complex Interdependence this would augment the vested interest in that relationship and to explain why Kazakhstan is where it is and possesses what it does that makes it the centre of long term energy perspective in India within Eurasia that Heartland Theory would be employed.

CHAPTER 5
EXPERT PERSPECTIVES ON INDIA'S NUCLEAR ENERGY POLICY TOWARDS KAZAKHSTAN AND CENTRAL ASIA

5.1 Introduction

The present chapter highlights the expert perspectives with regard to India's nuclear energy policy in relation to Central Asia with special focus on Kazakhstan in the era of growing energy demands and growing concerns thereby. In the present times, energy is termed as the lifeblood for economic growth, industrial development, technological innovations and national security as well. India being the largest populated nations and emerging global economy largely faces the issues pertaining to excessive reliance on fossil fuels and energy security. In this milieu, it becomes imperative that India diversifies its energy base that is clean, reliable and long-term availability. Thus, in the picture, Central Asia with special reference to Kazakhstan holds greater importance as it became the emerging partner for India due to abundant potential resource base for uranium reserves, geo-political location and growing diplomatic relations between the two.

The findings obtained were obtained primarily via qualitative data collected through in-depth interviews with 12 purposively selected respondents. The respondents were selected because of their professional experience and substantive knowledge relating to energy, nuclear policy, engineering, energy security, Central Asian studies and related policy domains. The existing respondent profile demonstrates professional diversity, including engineers, academicians and personnel associated with energy-related institutions. The purpose of the interviews was not statistical generalisation but the generation of informed expert perspectives capable of complementing the documentary and policy analysis undertaken in the preceding chapters. The interviews were therefore used to identify recurring perceptions, areas of agreement, areas of disagreement and expert assessments of the opportunities and constraints affecting India's nuclear-energy engagement with Kazakhstan and Central Asia. The qualitative evidence was analysed thematically. Responses were organised according to the major analytical dimensions of the study, including India's energy vulnerability, the role of nuclear energy, the strategic importance of Central Asia, Indo–Kazakhstan nuclear cooperation, geopolitical and

logistical constraints, policy recommendations and sustainability concerns.

5.2 Profile of Key Respondents

This section outlines the profile of key respondents (12) including their gender, age, educational background, years of experience, designation and expertise in the relevant domain. The profile of the selected respondents is outlined in the tabular form as mentioned below (Table 5.1):

Table 5.1: Profile of Key Respondents

Respondent No.	Age (in Years)	Gender	Education	Years of Experience	Designation	Expertise
R1	56	Male	B. Tech.	32+	Chief Engineer	Hydropower
R2	56	Male	B. Tech. & MBA	20+	Director	Solar Energy
R3	56+	Male	B. Tech.	20+	Chief Engineer	Hydraulic
R4	34	Female	Ph.D.	>5	Academician	Central Asian Studies
R5	35	Male	Ph.D. & PDF	>8	Academician	Energy Security
R6	42	Female	Ph.D.	>15	Academician	Energy Security
R7	43	Male	B. Tech.	18	Executive Engineer	JKPDD
R8	43	Male	B. Tech.	16	--	JKPDD
R9	45+	Male	B. Tech.	16	--	Electric Department
R10	32+	Male	B. Tech. & M.A. Public Policy	18	--	Electric Department
R11	43	Male	B. Tech.	10	--	Electric Department
R12	39	Male	Ph.D.	>8	Academician	Energy Security

Source: *Compiled by Scholar*

The study retained the original sample of 12 respondents because the purpose of the primary research was to obtain specialised expert perspectives rather than to generate statistically representative findings. The respondent profile demonstrates diversity in professional background, educational qualification, experience and area of expertise. The respondents included engineers, academicians and professionals associated with energy and electricity-related institutions. Several respondents possessed substantial professional experience, while academic respondents contributed expertise in energy security and Central Asian studies. The purposive approach was therefore appropriate for identifying information-rich respondents who could address the specialised subject matter of nuclear energy, uranium security, energy diplomacy and Central Asian geopolitics. In the given milieu, the subsequent section outlines the analysis of data (qualitative via in-depth interview schedule) under the appropriate themes as outlined below:

5.3 Thematic Analysis

This section presents the thematic analysis of the content/subject matter under appropriate themes. Each interview lasted approximately 30-45 minutes and was conducted through [face-to-face] interaction, depending upon respondent availability and geographical accessibility. The researcher followed the same core interview schedule for all respondents while allowing additional probing questions where respondents raised issues of particular relevance to the study. This approach facilitated consistency in data collection while preserving the depth characteristic of qualitative expert interviews. In view of this, the themes are in-sync with research objectives while maintaining coherence with the interview schedule. The findings as presented in this section are supported by secondary data (wherever applicable). At large, there are seven themes where the subject matter has been presented systematically as mentioned below:

Theme 1: India's Energy Vulnerability

In view of the given context, there is uniformity of responses as respondents have termed India's energy vulnerability as a major strategic concern that primarily arises from import of crude oil and natural gas from external sources (primarily Gulf Cooperation Council Countries).

R1 calls India as highly vulnerable country from energy perspective due to heavily

dependence on oil imports. R4 and R5 calls Indian energy security as a "Strategic Issue" due to its volatility and over-dependence on external markets. In view of R9, R10 and R11, the energy dilemma has a direct bearing on economic stability.

Moreover, in the above background, the respondents have also identified the structural challenges that affect the energy security in India. The "Lack of Policy Support for Indigenous" power generation, "Localization of Power Generation" and "Minimizing the Transmission Loss" have the potential to enhance energy resilience. R3, R7 and R9 have attributed worsening energy scenario to "Infrastructure Deficits", "Major Reliance on Imported Technology including Nuclear" and "Outdated Infrastructure". This is further amplified by "Geo-Political Risk" i.e. across choke points (such as Persian Gulf) while importing oil, "Limited Strategic Reserves" and "Infrastructural Gaps" thereby (R12).

Therefore, in view of above discussion, it can be inferred that India's increasing demand for energy combined with import dependence and infrastructural lacunas continue to intensify the energy vulnerability of country.

Theme 2: Role of Nuclear Energy in India's Energy Security

India in line with global standards tried to diversify the energy sources aimed at ensuring the energy security. The technology transfers in context to nuclear energy from Russia is the point of interest. In this milieu, the respondents have shown uniformity in their responses.

In view of this, majority of respondents have termed "Nuclear Energy as Vital for India" although they have cautioned with the "Inherent Risks" as well. The respondents have termed nuclear energy as cost-effective, environmental friendly (low carbon emission) and large-scale source of electricity with the potentiality to minimize the reliance on important dependence on fossil fuels (natural gas and oil). R7 and R12 have described nuclear energy as "Extremely Significant" as it provides stable baseload power, minimize reliance on fossil fuels and supports the efforts of decarbonization. R12 further agrees upon that nuclear energy is the "Primary Catalyst" in achieving the "Net Zero Emissions" by 2070; thereby reducing reliance on energy imports as well.

Despite the positive strides associated with nuclear energy as outlined above, the respondents have identified various policy and institutional constraints that limit the expansion/growth of nuclear energy in India. The identified issues include:

- Primarily, concerns regarding security vulnerability i.e. "loose technology" and "contracting administration" i.e. joint ventures between India and Other countries increases the prospect of infrastructure failures.
- Secondly, concerns regarding import of "Uranium and technology", project costs, environmental clearances and safety concerns are looming around.
- Thirdly, high capital cost, technology dependency, land acquisition delays etc. also affect the operationalization of nuclear energy facilities in India.

Therefore, in the above background, it can be inferred that respondents have stressed the necessity of nuclear energy in India, but also suggested the measures including institutional reforms, strong regulatory mechanism for "Sustainable Expansion" of nuclear sector.

Theme 3: Strategic Importance of Central Asia and Kazakhstan

Central Asia with special reference to Kazakhstan occupies the strategic position in India's nuclear security and diplomacy. The respondents have largely agreed upon that Central Asia holds immense potential in terms of "Oil, Natural Gas and Uranium".

Kazakhstan in particular occupies the prominent place when it comes to strengthen the energy sources and "Strategic Geopolitical Partnership". In view of R7 and R12, Kazakhstan is important from Indian perspective as it holds vast reserves of "Uranium" thereby strengthening the connect between the two countries. The respondents have further termed Kazakhstan as the "Largest Supplier of Uranium" critical for the generation of nuclear energy generation and "Diversification of Imports".

Moreover, Kazakhstan also offers various opportunities in the field of "Uranium Supply" and "Peaceful Nuclear Cooperation". Although, some respondents have expressed limited expertise in the given context; while as R4, R5 and R12 maintained that Kazakhstan offers "Reliable supply of Uranium and Technological Cooperation" in the realm of peaceful nuclear energy development. According to

R12, Kazakhstan offers "Non-adversarial and Stable and source of Uranium" for long-term "Strategic Reserves". Such an instances also creates the possibility for collaboration in "Small Modular Reactors, Waste Management and Technology" thereby.

Therefore, in view of above discussion, it can be inferred that Kazakhstan holds immense potential being the reliable partner for India's expanding nuclear energy footprints. However, respondents have also reflected broader geo-political considerations attached India's engagement with Central Asia with particular focus on Kazakhstan. Respondents perceive Kazakhstan not only as a reliable source for energy, but as a "Strategic Gateway" for "Eurasian" region. Thus, strengthening cooperation with Kazakhstan holds immense scope for India's outreach and "Strategic Influence" in Central Asia.

Theme 4: Indo-Kazakhstan Nuclear Cooperation

The agreements in the realm of civil nuclear perspective hold greater importance in the Indian context. The India-Kazakhstan 2011 Nuclear Civil Agreement holds vital importance in securing nuclear fuel security and diversifying its Uranium base.

In the given context, there is a common consensus among the respondents that the said agreement is "Effective" in strengthening the India's nuclear energy security. R2, R3, R4, R5 and R12 have shown common faith that the agreement has enhanced the India's access to Uranium resources and diversified the "India's Nuclear Fuel Partnership". The agreement has ensured the steady supply of Uranium to India (R12). Thus, the common consensus indicates that the agreement has positively contributed to reducing India's dependence on limited nuclear fuel sources and strengthened the "Energy Resilience". Although, the agreement holds immense potential towards India; but is subject to major challenges as outlined below:

- Connectivity constraints between the two countries (R4 and R5).
- Geo-political instability in the region and transportation issues thereby *(ibid)*.
- In addition, geo-political competition and regional instability (R12)

In the above background, the respondents have suggested broader engagement including "Joint Research and Development", "Reactor Technology" and "Public-Private Partnership". Moreover, the relationship between the two countries shall move from

"Consumer Framework" to "Comprehensive Strategic Partnership".

Theme 5: Geo-Political and Logistical Constraints

Although the nuclear energy is termed as clean, reliable and cost-effective; but the transition from non-renewable sources of energy (Coal, Gas and Oil) to sustainable sources of energy including nuclear energy is not smooth. The transition is limited by multitude of factors largely categorized into geo-political and logistical constraints.

> In the view of respondents, geo-political and logistical constraints are the major challenges affecting the India's engagement with Kazakhstan in Central Asia in the realm of nuclear engagement. R1, R7 and R9 observe that "vulnerability multiplies with logistical barriers" primarily because offshore energy cooperation remains highly exposed to "military hindrance" in every supply route. Furthermore, R4, R5 and R12 have termed China's presence in Central Asian Region under the shadow of "Belt and Road Initiative (BRI)" as increasingly effective, thus limits India's "Strategic Space". Other than BRI, respondents also term China's economic and strategic influence in the region as greatest hindrance.
>
> R4, R5 and R5 (these respondents have visited many Central Asian Countries including Kazakhstan) have termed "Absence of Direct Connectivity" as an imminent impediment to energy cooperation between India and Kazakhstan. Furthermore, the absence of "Reliable Trade Corridors" and limited "Direct Connectivity" paves the way for increasing transaction costs; thereby delay the output of energy cooperation initiatives. The above cited respondents further underline that lack of direct trade routes and India's reliance on "Complex Transit Routes" paves the way for increase in supply-chain delay; thereby reducing overall efficiency and effectiveness of such diplomatic/strategic engagements.

Therefore, from the above discussion, it can be inferred that connectivity barriers, sanction regimes, regional conflicts and administrative delays etc. adds to the pool of challenges associated with nuclear energy engagement between India and Kazakhstan. In the given context, the respondents have outlined that "Risk-Averse Policy Framework" and "Minimal Progress in Joint Research and Development Ventures" continue to hamper the progress of "Civil Nuclear Agreement, 2011" between the two nations. Therefore, focus

shall be laid upon strengthening "Long-Term Strategic and Energy Partnerships" with Central Asia particularly with Kazakhstan.

Theme 6: Policy Recommendations and Future Prospects

Considering the challenges associated with India's nuclear cooperation with Kazakhstan, the respondents have suggested various policy measures. These measures are outlined below:

- India should diversify "Energy Partnerships" and built "Strategic Trust" through regular political/diplomatic engagement with Central Asian countries.
- Enhancing Connectivity: India shall undertake measures to improve the connectivity through "International North-South Transport Corridor (INSTC)".
- India shall initiate transition from "Supply Agreements" to "Comprehensive Nuclear Partnerships" including joint ventures in "Uranium Exploration" and "Technology Sharing".
- India shall strengthen the multilateral engagement through regional forums including Shanghai Cooperation Organization.
- Offshore energy sources shall be termed as secondary rather than primary sources of energy i.e. focus on increasing domestic, sustainable energy supply.
- Strengthening the connectivity via "Chabahar Port" and increase the India's active presence in various regional and international organizations.
- Focus shall be laid upon more investments into energy infrastructure, clean energy and faster project approvals.
- Strategic reserves shall be strengthened, institutional coordination shall be improved and private-public-partnership shall be promoted.

Therefore, in view of respondents, the given set of comprehensive policy measures hold vital importance to strengthen the India's energy security predicament.

Theme 7: Sustainability Dimension

Since the enactment of Sustainable Development Goals (SDGs) in 2015, the countries across the globe have transitioned to "Sustainability" led policy frameworks. The countries have initiated to bring fundamental changes in the policy domain that ranges from, social, economic and energy sector as well.

Although, the respondents have shown uniformity in their responses with regard to the importance of renewable sources of energy (solar, wind and hydro), their inclination towards the nuclear energy speaks the volume. Respondents largely agree that nuclear energy has the potential to cater the long-term, emerging energy demands in India and minimize the carbon emissions as well. R4, R5 and R12 have termed nuclear energy as "dependable and long-lasting source" of energy; however, also cautioned with the risks associated. Majority of the respondent's term nuclear energy as "reliable, carbon neutral and large-scale electricity generation" as capable of reducing the dependence on fossil fuels. Respondents further call this as "Sustainable Low Carbon Option" having potentiality to meet India's emerging "Energy Demands" and achieving the "Climate Targets".

The respondents have further highlighted the role of nuclear energy in catering the 30% energy component in India; thus massive relief to CO2 production. The expandable nuclear-energy footprints will minimize reliance on coal-based power, thus supporting the climate commitments. Moreover, the respondents have stressed upon the balanced integration of nuclear and renewable sources (wind, solar, hydro). Although, the renewable sources of energy are largely affected by location, weather and other natural factors, the nuclear energy will come into the rescue (backup source) in such circumstances. At large, the respondents agree upon the fact that nuclear energy provides stable "base-load supply", while as renewable sources provide "cleaner but intermittent power".

Despite all the positive strides as mentioned in the present section, the respondents have stressed upon the importance of "Nuclear Waste Management", "Nuclear Safety" and "Framework for Sustainable Nuclear Development". The respondents have termed "Safety and Waste Management" as two main liabilities that demand the stringent measures and scientific research.

5.4 Recurring Themes

Import Dependency: Localization of Power Generation

India primarily relies on import of fossil fuels including oil and natural gas; thus, this adds to the energy import bill. Moreover, such dependency is largely shaped by geo-

political factors that potentially affect the regular oil supply in times of crisis. Although, India transitioned to nuclear energy, but the fact remains that majority of the Uranium supply largely depends on other countries including Kazakhstan. In this milieu, the respondents have necessitated the fact that "Localization of Power Generation" shall be focused on. This core essence of the localization of power generation shall be sustainable (solar and wind energy) and having potentiality to minimize the transmission loss. Localization also helps in catering the societal needs as local level, empowers the rural communities (e.g. Solar Charkha Mission). Localization at large helps to minimize the dependency on energy import.

Nuclear Energy as Strategic Necessity

Nuclear energy is largely termed as a "Strategic Necessity" having the potential to diversify energy needs and achieve the climate targets. In view of respondents, the Nuclear energy has the potential to achieve the net-zero carbon target by 2070. The nuclear energy is a strategic necessity for India due to rapidly growing energy demand, increasing import dependence and long-term developmental needs. In the given context, the uninterrupted source of energy to sustain the industrialization, infrastructure and technological expansion holds the greater importance. In the long run, the strong nuclear energy supports the economic stability, environmental sustainability and strategic energy independence.

Kazakhstan as Reliable Partner for Energy Security and Gateway for "Eurasian Outreach"

The India-Kazakhstan 2011 Civil Nuclear Agreement strengthened the Energy Resilience in India. Kazakhstan holds the record of being the largest producer of Uranium; and the same enables it to ensure uninterrupted and stable uranium supply to India. Respondents largely agree that Kazakhstan contributes to strengthen the India's nuclear fuel security and 2011 agreement is the testament to the same. Unlike other countries which as highly volatile, Kazakhstan holds the record of being relatively stable diplomatic and economic engagement. Therefore, from strategic perspective, diversification of uranium sources is essential for minimizing the geo-political and market fluctuations.

Shift from "Consumer Framework" to "Comprehensive Strategic Partnership".

Primarily the relationship between India and Kazakhstan war merely diplomatic engagement with limited discussions on energy cooperation. However, since the last two decades, the dynamics of relationship underwent fundamental transformation. The growing significance of India's energy security and 2011 Civil Nuclear Agreement are landmarks in expanding the scope of this relationship. Respondents, in this regard highlighted that India can no longer rely on theoretical or policy-level frameworks; but operationalize and institutionalize strong strategic mechanism with Kazakhstan. Such an arrangement strengthens the mutual trust and demonstrates the strategic importance of Kazakhstan in supporting the long-term energy needs of India. Moreover, the comprehensive framework shall move beyond the energy import and focus on technology transfer and scientific exchanges.

Connectivity and Geo-political constraints

The respondents have highlighted lack of direct land connectivity and reliance on complex transit routes as emerging challenges that hinder the effective energy cooperation between the two countries. These constraints have the potential to increase the energy costs, delay the energy projects and limit India's outreach program. Moreover, the Belt and Road Initiative (BRI) of China limits India's "Strategic Space" in the Central Asian Region. Thus, strengthening the INSTC and Chabahar Port are vital in strengthening this cooperation.

Safety and Regulatory Concerns

Although, the nuclear energy holds the record of being reliable and long-term availability; there are inherent issues that limit its scope. In view of respondents, Safety and Waste Management" are two main liabilities that adds criticism to the nuclear energy. The concerns regarding nuclear accidents, technological vulnerabilities, weak institutional oversight and operational risks are also looming around.

At large, the recurring themes regarding expert perspectives highlight that India's energy challenges are multidimensional i.e. strategic, geo-political, sustainability, technology, over-reliance on fossil imports. Although, in this background, the nuclear energy is termed as reliable, long term solution to cater India's energy demands and achieving climate goals,

the respondents attribute its success largely depends on “Diversified Energy Diplomacy”, “Enhanced Connectivity”, “Effective Institutional Mechanisms” and “Sustainable Regulatory Frameworks”.

5.5 Areas of Convergence and Divergence among Respondents

The interview findings reveal substantial agreement among respondents concerning India's energy vulnerability and the strategic importance of nuclear energy. However, the interviews also reveal differences in the degree of emphasis placed on particular policy options. These differences are analytically significant because they demonstrate that expert opinion does not constitute a single homogeneous position.

Nuclear Energy versus a Broader Energy Mix

Most respondents regarded nuclear energy as an important component of India's long-term energy strategy because of its potential contribution to reliable electricity generation and reduced dependence on fossil fuels. However, some respondents emphasised that nuclear expansion should not be interpreted as a substitute for renewable energy. Their responses supported a balanced energy strategy in which nuclear energy, solar, wind and hydropower complement one another.

This divergence suggests that the strategic value of nuclear energy lies not necessarily in replacing other energy sources but in strengthening the resilience and diversity of the overall energy mix.

Depth of Dependence on Kazakhstan

Respondents generally viewed Kazakhstan as an important and reliable uranium partner. Nevertheless, the degree to which India should deepen its dependence on Kazakhstan differed across responses. Some respondents favoured stronger long-term engagement, including investment and technological cooperation, whereas others emphasised diversification of suppliers to avoid replacing one form of dependency with another.

This distinction is particularly relevant to Complex Interdependence

Theory. Kazakhstan can provide India with greater energy security, but excessive concentration on a single supplier may simultaneously create a new form of vulnerability. The strategic objective should therefore be deeper engagement with Kazakhstan combined with broader supplier diversification.

Contractual Cooperation versus Equity Participation

A further difference concerned the preferred model of engagement. Some respondents viewed long-term government-to-government contracts as sufficient to maintain fuel security, whereas others argued that India should gradually move towards equity participation, joint ventures and upstream investment.

The difference reflects the distinction between access and influence. Contractual arrangements provide access to a resource, whereas equity participation can potentially provide a greater degree of involvement in production and supply-chain decisions. This distinction corresponds closely with the Structural Power analysis developed in Chapter 4.

Connectivity Priorities

Respondents broadly identified connectivity as a major constraint but differed in their assessment of the most effective response. Some emphasised the International North–South Transport Corridor and Chabahar Port, while others stressed the importance of developing multiple alternative routes and broader trans-Caspian connectivity.

The divergence does not undermine the overall finding that connectivity is a constraint. Instead, it demonstrates that the policy response should be diversified rather than dependent on a single corridor.

Nuclear Safety and Sustainability

Respondents generally recognised nuclear energy's potential contribution to a lower-carbon energy system. At the same time, some placed greater emphasis on safety, radioactive-waste management, institutional oversight and regulatory capacity.

This divergence indicates that support for nuclear energy is conditional

rather than unconditional. Nuclear expansion is viewed as strategically desirable only when accompanied by effective safety regulation, technological capability, institutional capacity and responsible waste management.

5.6 Conclusion

The present chapter has analyzed the expert perspectives on India's Nuclear Energy Policy with special focus on Kazakhstan and Central Asia from the broader context of India's security and diplomatic perspective. The analysis is primarily based on primary data collected from in-depth interview of selected respondents using the interview schedule. The findings of the study have revealed that there is common consensus among the respondents regarding India's growing dependence on import of crude oil, natural gas, that largely adds to energy vulnerability to India. The respondents have further underlined various structural challenges viz. limited domestic production, infrastructural deficits, technological limitations, geo-political risks/uncertainties across the transit routes. In this milieu, nuclear energy holds strategic importance in the realm of India's long-term energy framework. Respondents perceive nuclear energy as reliable, green and capable of minimizing reliance on fossil fuels, thus supporting the India's commitment to achieve climate targets. However, these developments are being hindered by technological dependence, high capital costs, nuclear safety etc.

This chapter further highlights the significance of Central Asian region with particular focus on Kazakhstan in the realm of India's nuclear diplomacy. Respondents perceive Kazakhstan as largest supplier of uranium and important "Strategic Partner" holds immense role in the diversification of India's energy needs. The 2011, India-Kazakhstan Civil nuclear agreement is perceived as an important milestone that strengthened India's access to Uranium and expanded the scope of bilateral relations between the two countries. However, a faction of respondents has cautioned about the persistent geopolitical and logistical risks associated with the achievement of objectives of this agreement. The growing Chinese presence, lack of direct trade routes, regional stability, sanctions regime and reliance on complex transit routes further limit the scope of this engagement. In light of this, the respondents have laid focus upon connectivity initiatives with particular focus on "International North-South Transport Corridor (INSTC)" and "Chabahar Port" supplemented by cooperative multilateral engagement through regional platforms such as

"Shanghai Corporation Organization (SCO)". The respondents term these measures as vital for expanding the nuclear footprints in the region.

Moreover, the findings also underscore the emerging importance of sustainability discourse in India's nuclear energy policy. Respondents largely agree that "Nuclear Energy" plays an important role in minimizing the carbon emissions and acts as a "Means" to transition towards, cheaper, cleaner and sustainable energy future. However, the respondents emphasized that a balanced approach i.e. integration of solar, wind and hydropower in the sustainability shall be focused on. The respondents have also cautioned with the risks associated with nuclear energy including safety standards, management of radioactive waste, effective regulatory framework and import dependence.

CHAPTER 6
CONCLUSION AND STRATEGIC RECOMMENDATIONS

6.1 India's Energy Vulnerability and Strategic Uranium Partnership with Kazakhstan

This study critically examined the energy vulnerability of India and how its nuclear energy policy has evolved towards Central Asia, especially Kazakhstan since 1991. The long-term economic development of India, its desire to increase the nuclear power base, and the national interest towards the low-carbon developmental directions have increased the strategic urgency of ensuring reliable and affordable uranium sources. The low domestic uranium reserves in India and the fact that the country relies on foreign sources of power by 80 percent has however revealed a major structural flaw in its energy security system. It is against this background that Kazakhstan has become a cornerstone in the nuclear energy plan of India, as it is the largest uranium producer in the world (having produced about 40% of the world output) and has recoverable reserves of over 900,000 tonnes. Since Indo-Kazakhstan uranium supply agreement was signed in 2009 and government-to-government (G2G) contracts were operationalised in 2011, Kazakhstan has continuously supplied 35-55% of the total uranium imports to India, thus, facilitating the continued operation of the civilian nuclear programme of India.

These bilateral deals between the Department of Atomic Energy (DAE) of India and the state-owned company of Kazakhstan, Kazatomprom, have guaranteed stable quantities, lowered vulnerability to the fluctuations of the spot market and strengthened diplomatic goodwill. However, with the results presented in Chapter 4 and Chapter 5, the position of India in the uranium industry in Kazakhstan is still structurally limited and more exposed to a fast changing geopolitical and economic landscape. Unlike China and Russia, India does not possess equity stakes in Kazakh uranium mines, has limited participation in processing facilities, and lacks control over key logistical corridors. Such a non-equity, contract-dependent form of engagement greatly restricts the ability of India to influence the priorities of production, pricing standards, and export quotas to remain a price-taker in a highly competitive global economy. Based on the Structural Power Theory of Susan Strange, the limited participation of India in the Kazakhstan nuclear value chain, in comparison to the asset-based dominance of China and historical control of enrichment

technologies and transit infrastructure by Russia, affects its ability to affect the institutional and operational framework in terms of the uranium trade.

This competitive situation is also augmented by the equity-based approach by China using her state-owned ventures CGN and CNNC, which have acquired long-term ownership interests in some of the most prolific uranium deposits in Kazakhstan. As a part of the Belt and Road Initiative (BRI), the creation of transport corridors like the Western Europe-Western China route gives China a pronounced logistical upper hand and improves its bargaining power when it comes to maintaining uninterrupted supplies. Similarly, Russia uses its enrichment leadership, transit and control via the Eurasian Economic Union (EAEU) and solidifies its position by performing the building of the first nuclear power station in Kazakhstan. At the same time, the Western powers, especially the European Union, the United States, Japan, and South Korea are getting more invested in Kazakhstan as a means of supply chain diversification in alternatives to Russian uranium after the war in Ukraine. Nevertheless, the level of their integration is rather superficial as a result of the geographical constraints and predisposition of Kazakhstan to collaborate with the partners who are willing to propose joint ventures, investment into infrastructure and transfer of technologies. In this multi-layered strategic environment, the weaknesses of India are multi-layered.

Although Kazakhstan considers India as a stable and harmless business companion, lack of upstream investment and integration of logistics compromises the bargaining power of India in the long-term. These dynamics are further revealed in the SWOT analysis of Chapter 4: India has the advantage of a proven diplomatic goodwill since the Strategic Partnership Declaration of 2009, adherence to the IAEA safeguards and its image of a responsible nuclear actor. Its weaknesses however are that it has not involved the equity participation, overreliance on Kazakhstan as a single large supplier, is vulnerable due to dependence on the limited transit routes like the INSTC and Chabahar Port and the bureaucracy delays in renewing contracts. New opportunities encompass the multivector foreign policy of Kazakhstan, the trend of the world of diversifying non-Russian nuclear fuel, the prospects of technological cooperation in advanced fuel cycles, and Small Modular Reactors (SMRs). Meanwhile, risks are also mounting, mostly because of the high integration of equity by the Chinese, the control of transit infrastructure by Russia, and the fluctuation in prices of uranium in the world market, as well as the growing rivalry

among the Western utilities in search of long-term supply security.

6.2 Scenario-Based Assessment of India's Uranium Security Outlook

These vulnerabilities are amplified when assessed through the scenario-based analysis presented in Chapter 4. In the best-case scenario, India secures stable uranium supplies at competitive prices by acquiring equity stakes, co-financing processing facilities, and diversifying logistics routes through the Middle Corridor and trans-Caspian networks. In the baseline scenario, India continues to rely on G2G contracts but remains exposed to price surges and periodic renegotiations, necessitating stronger multi-year agreements, stockpiling of strategic uranium reserves, and partial integration into upstream facilities. In the worst-case scenario, Kazakhstan's export priorities shift towards China and Russia, reducing India's allocation and forcing it to depend on alternative suppliers in Africa, Canada, or Australia at significantly higher procurement costs and longer lead times.

Regarding a Complex Interdependence approach (Keohane and Nye), the India-Kazakhstan nuclear relationship represents an asymmetrical dependence: Kazakhstan enjoys the benefits of India demand, but retains a diversified export base with China, Russia, France, Canada and Japan which gives Astana more freedom in reallocating supplies as strategic needs arise. Likewise, the experience of the Securitization Theory informs of how the uranium imports in India have transformed into a business deal to an imperative of national security, justifying the creation of special diplomatic routes and long-term G2G acquisition arrangements. Moreover, the Heartland Theory places the geographical centrality of Kazakhstan in Eurasia as a geographical opportunity to enable the integration of uranium trade with wider connectivity projects like the International North-South Transport Corridor (INSTC) and Trans-Caspian routes to allow India to be more logistically independent and resilient to energy security issues.

Overall, the data of this study confirms that although Kazakhstan is an essential part of the Indian nuclear energy policy, the current scheme of interaction that entails only contractual relations without the involvement of more profound structural organization exposes India to a range of serious long-term risks in the competitive and unstable global uranium market. To secure a safe future of its energy, India will need to redesign its pillars of strategic involvement by becoming not a mere contractual buyer, but an active participant in the nuclear ecosystem of Kazakhstan. This will require a combined approach

of equity in Kazakh mines, technology partnerships in advanced fuel cycles, infrastructural and diversified transport pathways and an increased representation in multilateral nuclear governance bodies such as the IAEA, SCO and BRICS. Only with this multidimensional, long-term strategy will India be in a position to safeguard its nuclear security in long-term and mitigate external vulnerability and also enhance its strategic autonomy against the evolving global energy scenario.

6.3 India's Energy Vulnerability

The energy vulnerability of India, its developing nuclear energy policy, and the issues that the nation faced in sustaining its uranium supplies with Kazakhstan, in the context of the increasing global competition, are complexly connected as the results of this study demonstrate. India nuclear energy programme, which has been at the centre of the energy mix diversification and low-carbon growth in the country has increasingly become a critical factor as the country seeks to meet its increasing electricity demands. Nonetheless, these aspirations are limited by the small reserves of domestically produced uranium and a general reliance on external energy sources of 80 percent, which makes India one of the most import-dependent large economies in the world. As noted in Chapter 4, uranium procurement reliability is the core of the Indian nuclear security system, and therefore, long-term stable supply arrangements appear as a strategic imperative, rather than a purely commercial one.

In this context, Kazakhstan has become the largest and most reliable uranium supplier to India, due to the outstanding endowment of its resources and reliability of its institutions. Kazakhstan is the world leader in uranium production, providing almost 40 percent of the world before, with recoverable reserves of over 900,000 tonnes, which is almost invaluable to the global nuclear fuel supply chain. Kazakhstan has continuously supplied India with between 35-55 percent of its total uranium needs since the 2009 Indo-Kazakhstan Uranium Supply Agreement and the historic 2011 Civil Nuclear Cooperation Agreement, with structured government- to-government (G2G) agreements being part of its share in total uranium supplies with the Department of Atomic Energy (DAE) of India negotiating with the state owned company, Kazatomprom. These agreements have guaranteed stability in fuel purchases, cushioned India against international spot-market pull and shove, and guaranteed that civilian nuclear power plants will keep running.

Notably, this stability was hit at a critical point because the global uranium price increased by over 50 percent since 2021 on the back of growing demand in the context of net-zero energy transitions.

Nevertheless, the results also highlight the fact that the interaction of India with Kazakhstan, though being strategically important, is still transactional, but not structural, thus, placing the country at the risk to the changing forces of the market environment and geopolitics. India, in contrast to China and Russia, does not have an equity stake in Kazakhstan uranium production, very little stake in processing facilities, and control of key transportation links. Equity-based approach by China via China General Nuclear (CGN) and China National Nuclear Corporation (CNNC) is guaranteeing ownership shares in various Kazakh uranium projects and integrating uranium logistics into the Belt and Road Initiative (BRI) through routes such as the Western Europe Western China route, providing Beijing with priority access and high price leverage. Russia, in its turn, has its own leverage in enrichment possibilities, control of transit infrastructure and control of regulations through the Eurasian Economic Union (EAEU). Furthermore, the recent construction of the first nuclear power plant in Kazakhstan by Moscow has made it even more integrated into the nuclear ecosystem in this country. Western powers, especially the European Union, the United States, Japan and South Korea have also increased their involvement in Kazakhstan with the aim of diversifying supply chains since the conflict with Ukraine, but their integration is limited compared to that of China and Russia because of geographical distance and preference of partners who provide equity based investments and technological cooperation. Such comparative disadvantage reflects the structural weakness of India in the uranium sector of Kazakhstan which is directly proportional to the knowledge gained out of Structural Power Theory of Susan Strange.

The non-equity, contract-based system of India limits its power to affect the production priorities, pricing mechanisms and export quotas, which curtails its strategic freedom in nuclear fuel procurement. Conversely, China and Russia are structural powers since they influence the actual structures through which the flows of uranium in the world are regulated. Securitization Theory is another theory that can be used in explaining the actions of India: the acquisition of uranium has been presented within the Indian context as a national security necessity, which has justified G2G arrangements and the development of strategic stocks of nuclear fuel to maintain continuity of reactor operations. But as

Complex Interdependence Theory (Keohane and Nye) reveals, the Indo-Kazakhstan nuclear relationship is asymmetrical. Though India relies on Kazakhstan to supply as much as 55 per cent of its uranium demands, Kazakhstan sells uranium to a diversified group of Purchasers-China, Russia, France, Canada, and Japan-offering Astana more options on how to redistribute its supply, without exposing it too much domestic risk. Lastly, the lessons of Heartland Theory highlight the geographical centrality of Kazakhstan in Eurasia, which can provide India with ways to combine uranium trade with regional connectivity programs like the International North-South Transport Corridor (INSTC) and Trans-Caspian routes, which would allow India to reduce reliance on logistics through Russian-controlled channels and increase supply resilience.

These results are in line with the research objectives of this study. First, they establish that Kazakhstan is a practical and essential alternative to Indian nuclear energy security (RQ1) where it has constantly fulfilled a considerable portion of the Indian uranium demands. Second, they have underlined the structural weaknesses of India relative to its rivals, such as China and Russia (RQ4), demonstrating the weaknesses of an exclusively transactional G2G procurement paradigm. Lastly, they emphasize the necessity of strategic recalibration (RQ5), and they prove that without equity integration, technological cooperation, and logistics diversification, India would face long-term supply insecurity in a very competitive international market.

To conclude, the involvement of Kazakhstan in the continuing Indian civilian nuclear energy programme is both a strategic resource and a submerged threat. As surplus resources, political goodwill and institutional credibility in Kazakhstan have given India stability and predictability in fuel sourcing, India has been left vulnerable to competitive forces and changing geopolitical interests through its non-equity, contractual approach to sourcing fuel. The findings highlight the necessity of re-conceptualising the engagement strategy by India through transcending transactional procurement to integrated partnerships, which attain equity participation, technology transfer, infrastructure partnering and multilateral diplomacy. This is the change needed to guarantee long-term nuclear energy security of India and increase its ability to develop strategic autonomy in a constantly competitive and dynamic uranium market.

6.4 Indo-Kazakhstan Nuclear Cooperation

Indo-Kazakhstan nuclear partnership is a significant part of Indian approach in the participation of Central Asia, founded on reciprocal energy security, strategic faith and responsible nuclear conduct. The partnership is based on political goodwill and the observance of the International Atomic Energy Agency (IAEA) protection, which will guarantee a constant supply of uranium that will be needed by the growing nuclear energy programme in India. Almost 40 percent of world uranium production and supply with reserves in excess of 900,000 tonnes, Kazakhstan has become the largest and most reliable supplier to India, supplying 35 percent55 percent of its uranium requirements since 2011. Organized government-to-government (G2G) contracts between the Department of Atomic Energy (DAE), India and Kazatomprom have stabilized procurement and hedged India against international spot volatility after the 2009 Uranium Supply Agreement and the 2011 Civil Nuclear Cooperation Agreement. Besides these successes, Chapter 4 draws attention to a structural drawback: the interaction between India is contractual in nature, not based on equity relationships, and there is no technological interaction and inclusion in the production and logistics complex of Kazakhstan.

China, in turn, gains equity interests in Kazakh mines through CGN and CNNC and makes uranium provision a logistical instrument of dominance, whereas Russia uses expert knowledge of enrichment, transit control and influence in the context of the Eurasian Economic Union (EAEU). Such combined strategies make them more bargaining power as compared to the transactional model in India. Using the Structural Power Theory, India cannot leverage its position in the upstream value chains to drive prices and production priorities, and Complex Interdependence Theory shows that there is an asymmetry: India is heavily dependent on Kazakhstan, whereas Astana has diversified its export base, which provides it with freedom. India has to restore the balance in the strategy by ensuring that it concentrates on the equity integration, technological collaboration, diversification of logistics and multilateral collaborations as a way of establishing its nuclear energy safety over a long period of time.

6.5 Geopolitical Competition in Kazakhstan's Uranium Sector

The vulnerability of Indian uranium acquisition policy is further complemented by the increasing geopolitical rivalry in the uranium business in Kazakhstan that has become a

strategic battle line among the major world powers. Kazakhstan is now at the centre of the global energy transformation, as it is nearly forty percent of the world uranium production with more than 900,000 tonnes of the recoverable reserves and the resources have become the source of intense disputes. China has taken a very integrated and equity based approach in its state owned companies, China General Nuclear (CGN) and China National Nuclear Corporation (CNNC) to achieve significant ownership positions in several of the Kazakh uranium developments, including Semizbai-U and Ulba Metallurgical Plant strategic alliances with Kazatomprom. Within the Belt and Road Initiative (BRI) logistics system, incorporating uranium flows, such as the Western Europe-Western China one, Beijing has reaped two benefits simultaneously: preferred access to transport and pricing power. This integration allows China to have continuous supplies to its growing number of nuclear reactors, affect the decision of Kazakhstan production, and increase its structural power in the global uranium markets.

Russia keeps having great influence, including its enrichment superiority, the history of cooperation with Kazatomprom, and the control of the transit routes that the uranium exports of Kazakhstan have to go through. Russia is shaping the regulatory standards with the help of the Eurasian Economic Union (EAEU) as it further becomes part of the civil nuclear infrastructure of Kazakhstan through the construction of a first nuclear power plant in the country. This puts Moscow in the role of a technological ally and a logistical chokehold, providing it much leverage over the situation of the regional uranium traffic. In comparison, Western influence in Kazakhstan has been more pronounced, particularly by the European Union, the United States, Japan and South Korea after the rupture of Russian supply lines by the conflict in Ukraine. Their policies are oriented on diversification of supply, technology and mid-term contracts to reduce the dependence on Russian enrichment. The Western influence is however, relatively minimal due to the geographical boundaries, the complex regulatory processes, and the inclination of Kazakhstan to find partners that can offer it equity entry, infrastructure funding, and technological collaboration, which China and Russia have been able to secure already.

With the Structural Power Theory of Susan Strange, the hegemony of China and Russia is due to the ability to control the means of production, transport system and institutional structures that allow them to set the rules of play in the Kazakhstan uranium economy. Meanwhile, under Complex Interdependence Theory, a significant asymmetry is

revealed, in which as Kazakhstan seeks a political and economic diversification of buyers, it has been structurally embedded with China and Russia, in such a manner that it is a path-dependent world, at the disadvantage of the late-entrants, including India and the Western utilities. Moreover, the Heartland Theory describes the physical centrality of Kazakhstan, which is situated in the heart of the Eurasian continent, and that is why the control of its uranium logistics routes, including the part in Russia, China, and the Caspian region, has become a defining factor of geopolitics rivalry. To conclude, the industry of uranium in Kazakhstan has developed into a strategic intersection of the conflicting global energy giants, where the equity-based strategy of China and the logistical hegemony of Russia have achieved a long-term lever, whereas the representations of the West are left at the periphery. In the case of India, such a competitive environment highlights the immediacy of moving beyond contract procurement to a structurally integrated form of engagement that involves equity participation, the diversification of transport corridors, and technological collaboration to ensure its long-term security in nuclear energy.

6.5 Reassessing India's Uranium Procurement Strategy: From Passive Buyer to Strategic Stakeholder

The non-equity and contract-based nature of the Indian strategy to acquire uranium resources in Kazakhstan puts India at a great strategic disadvantage in an ever-competitive geopolitical arena. Though Kazakhstan has become India's greatest and most consistent supplier of uranium, reliably supplying 35 percent to 55 percent of its fuel needs throughout the 2011 2024 period, India has not been able to exert much control over the wider uranium value chain because of its reliance on formal government-to-government (G2G) contracts with the Department of Atomic Energy (DAE) and Kazatomprom. India does not have the institutional power to influence the export priorities, pricing mechanics and logistics systems without the involvement of equity or integration into the upstream production system in Kazakhstan. According to Chapter 4, India is vulnerable to this transactional model, which has led to fluctuations in supply, increased procurement costs, and logistical vulnerabilities due to its limited transportation corridors, namely the International North-South Transport Corridor (INSTC) and the less developed Chabahar Port.

China, on the other hand, has implemented an equity-based model with its state-

owned enterprises, China General Nuclear (CGN) and China National Nuclear Corporation (CNNC), purchasing ownership stakes in the largest of several uranium projects in Kazakhstan and integrating the flow of uranium into the Belt and Road Initiative (BRI). This allows Beijing to control logistics routes such as the Western Europe-Western China and create joint ventures with Kazatomprom which allows it to have preferential access to supply and major pricing leverage. In the same vein, Russia is taking advantage of its enrichment superiority, transit power, and its regulatory power via the Eurasian Economic Union (EAEU) to impact on the export routes of Kazakhstan as it consolidates its presence by building the first nuclear power plant in Kazakhstan. The combination of these approaches by China and Russia gives them structural power so that they can influence institutional norms and production priorities, whereas India, in this contractual dependence, is not a rule-setter, but a price-taker in the global uranium market.

Through the Structural Power Theory advanced by Susan Strange, the low level of integration makes India unable to enforce its own rules and structures to regulate the trade of uranium and instead rely on the will of outside actors. More to this, Complex Interdependence Theory reveals one major asymmetry, whereas India is heavily dependent on Kazakhstan to provide its uranium, Kazakhstan exports remain diversified and includes China, Russia, France, Canada, and Japan as suppliers, with Astana having any amount of flexibility when directing its supplies in accordance with changing geopolitical priorities. According to the perspective of Securitization Theory, the framing of the procurement of uranium as a national security imperative in India has led to the justification of one-sided G2G deals and strategic stockpiling; this however has failed to be effective in the long run due to lack of structural integration.

These findings indicate the pressing necessity of India to re-align its approach of engagement such that to change its passive and contractual buyer to an active and strategic stakeholder. The multidimensionality of this transformation should involve the inclusion of equity in the uranium mines in Kazakhstan, the use of technology in advanced fuel cycles, diversification of logistics via trans-Caspian and INSTC routes and the multilateral energy diplomacy in the form of IAEA, SCO and BRICS. The lack of these structural changes has exposed India to the risks of being further ostracized with China and Russia gaining power and the Western powers growing greater power, and Indian nuclear power security being exposed to the whims of the market, to the whims of changing export preferences as well

as geopolitical realignments.

6.6 Theoretical Integration and Analytical Framework

The theoretical frameworks which are embraced in this work give the analytical background to the strategic positioning of India in the field of uranium industry in Kazakhstan in an extensive sense and give an understanding of the implications of findings. This paper demonstrates the structural barriers, geopolitical features and strategic spaces that characterize the Indian approach to the procurement of uranium and the security of its nuclear power by use of the Securitization Theory, Structural Power Theory, Complex interdependence Theory, and Heartland Theory.

The Theory of securitization can be used to shed light on how India has built up the procurement of uranium into a matter of national security, influencing its energy policy within and outside of India. After decades of limited access to international nuclear fuel markets before the 2008 U.S.-India Civil Nuclear Agreement, assured access to uranium became a key to the continued development of the expanding civilian nuclear programme in India. As Chapter 4 points out, the growth of nuclear energy in India relies greatly on Kazakhstan, which supplies between 35 percent and 55 percent of the Indian uranium requirements under the auspices of the well-planned government-to-government (G2G) agreements.

Department of Atomic Energy (DAE) and state-owned Kazatomprom of Kazakhstan. These special arrangements that follow the Uranium Supply Agreement of 2009 and the Civil Nuclear Cooperation Agreement of 2011 indicate a securitized policy making process in which the purchase of uranium ceased to be a subject of open-market competition, and became instead of a matter of diplomacy aimed at buffering reactor processes against spot-market fluctuations and geopolitical shocks. Securitization makes the focus on diplomacy negotiations rather than a mere commercial deal that India has given Nationalwide by presenting uranium as a national sovereignty concern. But this reactive nature of dealing is more focused on the stability of contracts as opposed to ensuring that it has the structural control over the international market of uranium which is challenging with the increase of geopolitical rivalry.

India has more strategic limitations as explained by Structural Power Theory

developed by Susan Strange. Structural power is based on the capacity to make institutional rules, to control production and to rule the flows in the market. The non-equity, contract-based approach in India does not give this leverage but puts India in a price-taking role. As compared to this, China and Russia have deep-rooted strategies of structural power. The state-owned enterprises in China, China General Nuclear (CGN) and China National Nuclear Corporation (CNNC) have equity interests in several of the Kazakh uranium projects, such as having a partnership with Kazatomprom at Semizbai-U and at the Ulba Metallurgical Plant. With the incorporation of the uranium supply chains into the Belt and Road Initiative (BRI), China has gained an advantage in securing the priority logistics links like the Western Europe-Western China, making the country an unrivaled participant in the market in terms of pricing and supply guarantees. Russia also uses its enrichment supremacy, regulatory power through the Eurasian Economic Union (EAEU), as well as command over key rail and pipeline transit routes to control export routes of Kazakhstan. The role of Moscow in the construction of the first nuclear power plant in Kazakhstan makes it even more integrated into the nuclear system of Kazakhstan and solidified the influence in the long term. In comparison, the absence of equity participation and logistical integration restrict India to the status of a contractual consumer, reliant on the desire of Kazakhstan to live up to the fixed term contracts in a more competitive world.

Indo-Kazakhstan nuclear relations are asymmetrical, as pointed out by Complex Interdependence Theory (Keohane and Nye). As India relies on Kazakhstan to provide about half of its uranium requirements, Kazakhstan enjoys a well-differentiated export base with uranium to China, Russia, France, Canada, Japan and South Korea. The diversification provides Kazakhstan with strategic flexibility to shift supply in reaction to evolving geopolitical pressures, rival bids, or evolving demand pressures. This asymmetry, which is explained in Chapter 4, not only weakens India as a bargaining power, but also exposes it to more supply-side risks, particularly with China and Russia gaining privileged access to India through equity-based alliances and integrated transport corridors. Moreover, the interconnectivity of the uranium flows around the world makes it the responsibility of any disturbances, be they the Russia-Ukraine conflict or the uranium sanctions by the West on Russian enrichment plants, to be diffused throughout the supply chain of India, which further exacerbates the risks of price volatility and allocation preferences.

Finally, there is Heartland Theory that was designed by Halford Mackinder, that emphasizes the geostrategic centrality of Kazakhstan within the Eurasian continent, as well as its role as a hub of the uranium supply logistics. Kazakhstan is in a strategic position in the crossroad of Russia, China, Europe and the Caspian region, which makes it a player in the establishment of the energy connectivity networks. The case of India is similar, as there is an opportunity to underperform reliance on the current Russian-controlled pathways with the help of buying the uranium and joining the new regional transportation projects, the International North-South Transport Corridor (INSTC) and the Trans-Caspian logistics network. The multivector foreign policy that Kazakhstan employs, able to balance relationships with China and Russia as well as Western powers and India, opens opportunities to New Delhi to invest in mutual infrastructure, diversify transit, and strengthen supply chains, as described in Chapter 4. Failure to actively engage in such initiatives would force India to be ostracized by the future uranium transit systems to be dominated by its rivals.

Collectively, these theoretical backgrounds indicate that the current contract-driven procurement policy of India fails to deliver in a fast-paced and highly competitive geopolitical landscape. Securitization also underlines why India depends on diplomatic treaties, yet Structural Power Theory underlines that it is incapable of affecting the guidelines that regulate the uranium sector in Kazakhstan. Complex Interdependence shows the one-sided connection between the material dependence on one of the suppliers in India and the Heartland Theory incorporates the strategic role that can be played by Kazakhstan in the organization of the further uranium logistics systems. Together, they demonstrate the necessity of India to become an active strategic partner as opposed to a passive contractual participant. To effect this change, there must be equity in Kazakh uranium projects, and cooperation on advanced fuel cycles, diversification of logistics via INSTC and Trans-Caspian corridors and multilateral energy diplomacy in the IAEA, SCO, and BRICS. It is only with multidimensional integration strategy that India can enhance its bargaining power, assure itself of long term uranium supplies and protect its nuclear energy security in an age of increasing international competition.

6.7 Limitation

The study faces some inherent limitations as outlined below:

Data and Methodological Constraints

The research primarily relies on limited primary data (only 12 key respondents) and secondary sources of data including policy papers, think-tank reports, international energy statistics and scholarly publications. Although these offer a good base of studying the uranium procurement strategy in India, lack of access to confidential Indo-Kazakh uranium deals is still a major limitation. Bilateral contracts negotiated between the Department of Atomic Energy (DAE) of India and Kazakhstan, especially the ones that were signed in 2009 and 2011 are not entirely disclosed as observed in Chapter 4. Lack of such data limits further examination of pricing structures, production priorities and export guarantees. Also, the absence of extensive (More number of respondents) first hand work in Kazakhstan restricted the possibility of getting firsthand information of the government officials, executives at Kazatomprom and energy regulators. This involvement would have helped to explain the informal dynamics of negotiation that influence the decision-making process on the allocation of uranium and the pricing process. To illustrate, the case of China which offers preferential treatment via equity interests in the Kazakh mines like Semizbai-U and Ulba Metallurgical Plant is hard to assess without inside records.

This hinders our perception with respect to the bargaining position of India in terms of Structural Power Theory. Without understanding of the decision-making and contractual relations on the territory of Kazakhstan, it is not possible to judge the possibility of India to influence the production quality and certain influence on the organization of uranium as a resource. Future studies should employ the mixed-methods research to combine the secondary data with the structured interviews, field surveys and institutional data to produce a more detailed picture of the structural vulnerabilities of India.

Geopolitical Uncertainty

The results of the study are also sensitive to geopolitical instability in Central Asia and the worldwide uranium market. The interaction between India and Kazakhstan is also competitive with China, Russia and the western powers playing the lead roles in the business and thus the dynamics of supply is very unpredictable. As an example, the integration approach of China with its basis on equity-based involvement and Belt and Road Initiative (BRI) corridors enables it to receive priority access to uranium exports. Russia on the other hand has continued to exert influence by its enrichment dominance,

transit routes and regulatory leverage by the Eurasian Economic Union (EAEU). Uncertainty is further exacerbated by external shocks. The Russia-Ukraine conflict has changed the dynamics in transit, and Kazakhstan considers other options such as the Middle Corridor logistics network via the Caspian region, Azerbaijan, and Georgia. In the same manner, the sanctions imposed by the West on Russia have provided new motivation to diversify buyers to Kazakhstan, which could change the focus of exports not to India in case of the increase in competitive pressure in China and European utilities.

This volatility can be explained in terms of Complex Interdependence Theory, which demonstrates the one-sided reliance of India on Kazakhstan. India has been receiving 35 percent to 55 percent of its uranium supply through a relationship with Kazakhstan although Kazakhstan has been exporting to a diversified group of customers such as China, Russia, France, Japan and Canada. These relations imply that any small changes in the export-focused priorities or infrastructure orientation in Kazakhstan might dramatically interfere with the procurement policies of India. The future study must integrate scenario-based modeling and real-time monitoring of the policy to determine the resilience of the Indian supply of uranium due to changing shifts in power in the region.

Scope Restrictions

By covering Kazakhstan as the main uranium partner of India, the study allows to evaluate the bilateral cooperation in detail but restricts the scope of the comparative analysis. Although Kazakhstan provides an important portion of Indian demand of uranium, other suppliers who can play significant roles in the diversification of the Indian fuel basket include Australia, Canada, Namibia, and Uzbekistan. The findings are not quite representative of the overall attitude towards the acquisition of uranium and the position of India in the global uranium value chain with the focus on Kazakhstan. As an illustration, India has civil nuclear deals with Australia and its growing involvement with the Cameco Corporation of Canada opens more options to obtain enriched uranium. Nevertheless, these did not undergo an in-depth evaluation, which reduces the generalizability of the policy recommendations of the study. The inclusion of these dimensions in subsequent studies would enable a cross-country comparative framework that evaluates pricing frameworks, trustworthiness and strategic orientation among various suppliers. In the light of Securitization Theory, this limitation of the scope also impacts the completeness of the analysis. India describes uranium acquisition as a national security interest, but its future policy is starting to consider a balance between numerous suppliers to cut down on

the reliance on one supplier. Without assessing these parallel partnerships, the current study cannot fully evaluate India's risk mitigation strategies or its capacity to negotiate favorable contracts in a multipolar uranium market.

6.8 Future Scope and Policy Recommendations

The finding highlights why India should re-adjust its approach towards the procurement of uranium in order to ensure the country has a long term nuclear energy security in the face of increasing geopolitical rivalry within the Kazakhstan uranium industry. Although government-to-government (G2G) deals have ensured security in supply volumes since 2011, the use of a contractual, non-equity model has left India vulnerable to supply shocks, price volatility and lack of a competitive advantage compared to China and Russia whose integration is equity-based and ensures preferential treatment. In this part, a staged plan of short-term, medium-term, and long-term interventions aimed at improving the role of India in the uranium ecosystem of Kazakhstan and improving its strategic independence is offered.

Short-Term Priorities (1–3 Years)

In the short run, the primary concern of India should be to provide the continuity of uranium resources and at the same time develop resilience to the new geopolitical and market risks. The results of Chapter 4 show that Kazakhstan is the largest and most consistent supplier of India now outpicking 35 to 55 percent of the overall requirements of uranium as of the year 2011 and that is since the operationalization of government to government (G2G) contracts. Nonetheless, India relies on the contract-based procurement meaning that it is strategically disadvantaged in a competitive international uranium market characterized by the growing influence of China and Russia. India should address these risks by adopting three short-term priorities to direct the policy actions.

First India must enhance and expand its current G2G contracts with Kazakhstan state-owned Kazatomprom in uranium by negotiating fixed-volume and multi-year contracts at a stable price. Long-term deals will provide predictable fuel cycles to the reactors in India and hedge against spot-market real-time volatility, which has been compounded since 2021, when the price of uranium shot up by over 50% as the world clean-energy transitions and world supply disruptions following the Russia-Ukraine conflict. These

contracts will also cushion India against reprioritization of exports by Kazakhstan towards other large suppliers especially China, which has achieved preferential treatment by purchasing shares in the mines of Kazakhstan.

Second, India has to develop strategic stockpiles of uranium that would last at least 2 years of domestic reactor demand. As the reactor fleet in India increases to 22 GW of nuclear capacity by 2031, consumption will increase dramatically. The formation of reserves will also protect the nuclear energy programme against supply chain shocks, price increases, and geopolitical interruptions by sanctioning, conflict, or logistical blockages. The same approach has already been taken by China and the United States, who stockpile their uranium reserves at a level that is equal to several years of demand in order to cushion against any sudden discontinuity in the market. In the case of India, a strategic reserve would boost the security of energy and leverage during negotiations with suppliers.

Lastly, India should focus on the establishment and expansion of the Middle Corridor logistics network a trans-Caspian transportation channel that will provide Kazakhstan with the Azerbaijan, Georgia, and then to the world shipping centers. By going around Russian-controlled transit routes, this corridor minimises the exposure of India to the regulatory pressures of Moscow and geopolitical uncertainties. Since Chapter 4 observes that more than 80 percent of Kazakh uranium exports now pass through the territory of Russia, it provides a real bottleneck to Indian supplies. Investing in connection infrastructure allows India to diversify its logistics routes and co-finance port modernization, collaborate with the stakeholders of the ecosystem of Kazakhstan uranium to increase its bargaining power. In addition, this initiative ought to be coordinated with International North-South Transport Corridor (INSTC) to provide a coordinated system that links to India on the imports of uranium into the energy and trade relationship at large.

These immediate interests are critical to balancing the supply chain of Uranium in India, to cut over reliance on transit routes controlled by Russia, and to counter the growing power of China in the Uranium industry in Kazakhstan. India will be able to establish operational resilience to respond and place itself in a more competitive position in the world market of uranium by purchasing long-term contracts, establishing fuel reserves and diversifying transport infrastructure. Such groundwork measures will also establish the structural prerequisites that will ensure India engages in medium-term strategies of integrating the equity, and upstream involvement in the uranium value chain in

Kazakhstan.

Medium-Term Strategies (3–7 Years)

In the medium term, India should transform its position to a passive contractual buyer to an active strategic stakeholder in the uranium business of Kazakhstan to enhance its nuclear energy security in the long run. As discussed in Chapter 4, Kazakhstan now delivers between 35 percent and 55 percent of the Indian demand of uranium under organised government-to-government (G2G) agreements. These agreements offer predictable volumes, but because India relies on a non-equity, end-user model, it has less control over pricing structures, production priorities and over supply allocations. To get out of these structural limitations, India will have to follow a multi-faceted approach of equity involvement, institutional collaboration and entering the upstream nuclear value chain of Kazakhstan. The investment in the minority equity stakes should be the top priority-between 10 to 25 percent in the main mines of Kazakhstan uranium by Kazatomprom. This would enable India to gain preferential access to mined uranium, control the production schedules, and have an insight on the pricing negotiations. This integration is necessary, especially when China with its state-owned enterprises China General Nuclear (CGN) and China National Nuclear Corporation (CNNC) has implemented the equity-driven approach, which guarantees priority access to supplies and integrates the logistical framework of uranium in the Belt and Road Initiative (BRI). The joint ventures of china with Kazatomprom such as Semizbai-U mine and Ulba Metallurgical Plant show that equity participation gives it leverage in market allocation decision and contractual models.

In the absence of such integration in terms of structure, India can be pushed to a backburner in times where competition occurs in suppliers or geopolitical chaos. In order to institutionalize the cooperation, India can create an India-Kazakhstan Nuclear Cooperation Council (IKNCC) a permanent, high-level decision-making platform with policymakers, technical experts, and representatives of DAE and Kazatomprom. The Council would play a key role in the coordination of procurement initiatives, exchange of information about the world procurement of uranium and their alignment with increasing nuclear capacity objectives of India. The formalization of institutional connections can help India guarantee continuity in their policies, boost bilateral trust and actively control emerging risks in the supply-side rather than responding to market changes. Also, fuel processing plants, conversion and enrichment plants should be co-financed with

Kazakhstan on behalf of India. At present, India remains a mainly downstream consumer and buys processed uranium in the global market. Through incorporation of the upstream nuclear value chain, India would have more control over the conversion and enhancement processes and would be in a better place to negotiate more favourable pricing terms and also be in a better bargaining position compared to that of China, Russia and Western utilities. Putting up co-owned processing plants would also enable India to diversify its enriched fuel supplies, minimize supply chain bottlenecks and guarantee continuity of fuel supply to the projected 22 GW of nuclear capacity by 2031.

Such medium-term structural involvement would not only see India gain long term access to enriched uranium but also see it as an active stakeholder that can influence the regional structure of the uranium trade. India can fill its strategic gaps, level the entrenched dominance of China, and attain enhanced strategic autonomy in the global nuclear energy scene by emulating an equity-based, institutionally aligned, and value-chain incorporated strategy.

Long-Term Pathways (Beyond 7 Years)

A long-term multidimensional approach is required in which India will combine technological innovation, multilateral and institutional impacts to improve its role in the global nuclear energy governance and ensure long-term access to the uraniates of Kazakhstan. Although short- and medium-term implementation has to focus on stabilizing supply and integrate into the value chain of Kazakhstan uranium, the long-term priorities of India have to be focused on developing technological sovereignty, establishing strategic coalitions, and defining the institutional frameworks that control the trade of uranium in the world.

First, India needs to work with Kazakhstan on mutual research and development (R&D) programs on Small Modular Reactors (SMRs) and a thorium-based fuel cycle, which all are part of the three-stage nuclear power programme of India. The civilian nuclear policy of India, as discussed in Chapter 4, envisages a shift of the pressurized heavy water reactors (PHWRs) to advanced heavy water reactors (AHWRs) driven by a long-term plan of minimising reliance on imported uranium. Collaborative R&D with Kazakhstan would commercialize SMR technologies more quickly, and those have flexible deployment, lower capital costs, and safety qualities that make them especially appropriate

in the fast-urbanizing areas of India. In the same way, enhanced use of thorium would utilize India as a country with high levels of indigenous thorium deposits, and India could reduce its enriched uranium purchases as well as achieve energy independence. The cooperation with Kazakhstan, one of the major producers of uranium, would make sure a steady supply of fuel in these next-generation reactors in addition to enhancing bilateral relations in technology.

Second, India is to come up with triangular and multilateral relationships with the developed nuclear economies, Japan, South Korea, and the United Arab Emirates (UAE), to contribute funds, technologies and logistics to invest in the Uruguayan uranium industry. Such strategic alliances would give India a number of benefits. It is expected that India would increase its bargaining power and diversify its technology foundation and obtain preferential allocations of uranium by engaging in shared infrastructure and processing projects. These alliances would similarly serve to dilute the deep-rooted Chinese control of the uranium enterprise in Kazakhstan, in which state-run companies such as China General Nuclear (CGN) and China National Nuclear Corporation (CNNC) have already acquired equity investments in key mines and etched the uranium logistics in the Belt and Road Initiative (BRI). A joint venture of investments and expertise among like-minded partners would enable India to offset the influence of China and still keep level with it regarding its competitiveness in the upstream value chain in Kazakhstan.

Lastly, there is need to institutionalize India in the global governance of uranium by increasing its role in multilateral platforms like Shanghai Cooperation Organisation (SCO), BRICS and the International Atomic Energy Agency (IAEA). Although India has been a reliable nuclear partner owing to its adherence to IAEA safeguards, it has not had a great impact on the policy systems and the market standards. The greater involvement in these platforms would enable India to shape policymaking, create convergences that are strategic with Kazakhstan and other Central Asian generators and position itself as a rule-maker and not a rule-taker in the new nuclear energy order. SCO enables India to expand its presence in the Eurasian energy corridors, and BRICS ensures an opportunity to create alternative funding uranium mechanisms to reduce the dependence on the Western dominated regimes of prices. Becoming an active member of the IAEA would help India contribute to the international safety standards, supply chain transparency, and non-proliferation systems, and would even enhance its image as a responsible nuclear power.

Taken together the long term strategies would assist India to transform its position in the uranium business of Kazakhstan to become a transactional importer rather than a multi-faceted technological partner and policy maker. The co-development of SMR and thorium technologies, in addition to investment into triangular investment partnerships, creation of multilateral norms of governance will allow India to have a greater degree of strategic autonomy as well as decrease the perceived influence of China, Russia, and Western utilities. By so doing, India would not only have a sustainable access to the uranium of Kazakhstan, but also have a predominant voice in the international nuclear energy transition as its interests are entrenched in the structures of the trade as well as innovation and institutional policy standards.

Although the work has shown that India has gone a long way in ensuring supply of uranium through its civil nuclear relationship with Kazakhstan, it also shows that there are some structural constraints to this relationship. India has managed to make Kazakhstan a trusted ally in its energy politics, but its contribution is largely a customer rather than an investor in the long-term in the nuclear sector of Kazakhstan. This weakness is more pronounced as compared to China and Russia, which have stronger infrastructural, financial and institutional presence in the region and thus have stronger structural power.

Moreover, despite the identification of connectivity projects like the International North-South Transport Corridor (INSTC) and Chabahar Port as the strategic facilitators of India to reach Central Asia, there is still a lack of operationalization and geopolitical and logistical limitations. This still constrains the potential of India to convert diplomatic interactions into long-term economic and strategic impact.

The results thus indicate that even though nuclear cooperation between India and Kazakhstan has a great potential, this would be effective in the long run, depending on other factors other than the uranium supply agreements. These are the building of solid logistical systems, more financial and technological investment, efficiency of regulation and the maintenance of diplomatic involvement. To this end, the IndoKazakhstan alliance is not an actualized vision of energy security, but an emerging strategic paradigm, which should be institutionalized and long-term policy-based.

REFERENCES

Agarwal, S., Ghosh, P., & Zheng, H. (2024). Consumption response to a natural disaster: evidence of price and income shocks from Chennai flood. *Energy Economics*, 131, 107323.

Aggarwal, A. (2024). Special Economic Zones in South Asia: Structural Change, Competitiveness and Growth. Routledge.

Ahmed, S. (2009). *India's Energy Diplomacy: Evolving Engagement in Central Asia*. New Delhi: Institute for Defence Studies and Analyses.

Asatryan, G. (2025). *Talibanland: Paradise Under the Shadow of Sabers in Afghanistan*. Palgrave Macmillan.

Astana Times. (2023, April). India's relations with Kazakhstan are of mutual benefit. *Astana Times*. Retrieved August 4, 2025, from https://astanatimes.com/2023/04/indias-relations-with-kazakhstan-are-of-mutual-benefit

Astana Times. (2024). *Kazakhstan's uranium industry: Sites and production.* https://astanatimes.com/2024/08/kazakhstans-uranium-industry-sites-and-production/

Astana Times. (2025). *Kazakhstan's multivector nuclear diplomacy: Who will build its first nuclear power plant?* https://astanatimes.com/2025/01/kazakhstans-multivector-nuclear-diplomacy-who-will-build-its-first-nuclear-power-plant/

Barbar, M., Mallapragada, D. S., & Stoner, R. J. (2023). Impact of demand growth on decarbonizing India's electricity sector and the role for energy storage. *Energy and Climate Change*, 4, 100098.

Barbar, M., Mallapragada, D. S., Alsup, M., & Stoner, R. (2021). Scenarios of future Indian electricity demand accounting for space cooling and electric vehicle adoption. *Scientific Data*, 8(1), 178.

Bardhan, R., Debnath, R., & Jana, A. (2019). Evolution of sustainable energy policies in India since 1947: A review. *Wiley interdisciplinary reviews: Energy and environment*, 8(5), e340.

Behera, A., & Gubaidullina, M. (2018). Between China and India: energy dimension of

Kazakhstan. *ХАБАРШЫ*, 4.

Bhattacharya, D. (2021). India-Central Asia Relations. *Indian Foreign Affairs Journal*, 16(4), 341-350.

Bhattacharya, D. (2022). India-Central Asia Summit: Shaping geopolitics in the extended neighbourhood. *Observer Research Foundation*.

Bisaria, R. (2013). *Connect Central Asia: India's Framework for Regional Cooperation*. New Delhi: Ministry of External Affairs.

Board, A. E. R. (2004). Department of Atomic Energy. *Drinking water specification in India. Delhi: Government of India*.

Bourbeau, P. (2011). The Securitisation of Migration: A Study of Movement and Order (1st ed.). Routledge. https://doi.org/10.4324/9780203829349

Boute, A., & Chikanayev, S. (2025, April 8). *The nuclear gamble: Kazakhstan, Russia, and the shifting energy landscape of Central Asia*. Georgetown Journal of International Affairs. https://gjia.georgetown.edu/dialogues/the-nuclear-gamble-kazakhstan-russia-and-the-shifting-energy-landscape-of-central-asia/

Bruegel. (2025). *Ending European Union imports of Russian uranium*. https://www.bruegel.org/analysis/ending-european-union-imports-russian-uranium

Brzezinski, Z. (2016). *The grand chessboard: American primacy and its geostrategic imperatives*. Basic books.

Bucher, R. G. (2009). *India's baseline plan for nuclear energy self-sufficiency* (No. ANL/NE-09/03). Argonne National Lab.(ANL), Argonne, IL (United States).

BusinessWire. (2025, February 28). *Uranium and thorium industry research 2025: Global and regional market review 2019–2024 and forecasts 2025–2034*. Retrieved August 4, 2025, from https://www.businesswire.com/news/home/20250228683066/en/Uranium-and-Thorium-Industry-Research-2025-Global-and-Regional-Market-Review-2019-2024-and-Forecasts-2025-2034---Supply Demand-Manufacturers-Suppliers-Prices-End-users---ResearchAndMarkets. com

Buzan, B., Wæver, O., & De Wilde, J. (1998). *Security: A new framework for analysis*. Lynne Rienner Publishers.

Carnegie Endowment for International Peace. (2024, March). *To secure Kazakhstan's*

uranium, Chinese players were compelled to accommodate local partners. https://carnegieendowment.org/posts/2024/03/to-secure-kazakhstans-uranium-chinese-players-were-compelled-to-accommodate-local-partners?lang=en

Chakraborty, R., Mehta, A., & Pillai, K. (2021). *Grid Reforms and Decentralized Energy in India*. Delhi: Energy Studies Institute.

Chatterjee, E. (2017). The limits of liberalization: The power sector. In *Political Economy of Contemporary India*. Cambridge University Press.

Chatterjee, E. (2024). Late Acceleration: The Indian Emergency and the Early 1970s Energy Crisis. *The American Historical Review*, 129(2), 429-466.

Chaturvedi, V., & Malyan, A. (2022). Implications of a net-zero target for India's sectoral energy transitions and climate policy. *Oxford Open Climate Change*, *2*(1), kgac001.

Chaudhury, D. R. (2023). *India's relations with Kazakhstan are of mutual benefit*. *The Astana Times*. https://astanatimes.com/2023/04/indias-relations-with-kazakhstan-are-of-mutual-benefit/

Chaudhury, D. R. (2026, February 24). *Kazakhstan to supply fresh uranium to India under new deal to fuel nuclear power plants*. The Economic Times. Retrieved from https://economictimes.indiatimes.com/news/economy/foreign-trade/kazakhstan-to-supply-fresh-uranium-to-india-under-new-deal-to-fuel-nuclear-power-plants/articleshow/128728157.cms?from=mdr on 28-08-2026.

Chong, J. (2010). *China's Energy Security and Uranium Strategy in Central Asia*. Beijing: Tsinghua University Press.

Coate, R. A., Griffin, J. A., & Elliott-Gower, S. (2015). Interdependence in international organization and global governance. In *Oxford Research Encyclopedia of International Studies*.

Cohen, A. (2006). *Russia's Energy Leverage in Central Asia*. Washington, D.C.: Carnegie Endowment for International Peace.

Curtis, M. M. (2007). India's Worsening Uranium Shortage (No. PNNL-16348). Pacific Northwest National Lab.(PNNL), Richland, WA (United States).

Dabhade, M. S. (2024). India's New Diplomacy in Central Asia: Analysing the First India-

Central Asia Summit. *In India and Inner Asia* (pp. 197-209). Routledge India.

Dadwal, R. S. (2007). *India's Quest for Energy Security*. New Delhi: IDSA Monograph Series.

Dash, P. L. (2013). *Central Asia and India: A Study of Emerging Political and Economic Patterns*. New Delhi: KW Publishers.

Department of Atomic Energy, India. (n.d.). *DAE Technology Transfer Activities*. Retrieved August 4, 2025, from https://dae.gov.in/dae-technology-transfer-activities/

Department of Atomic Energy. (2011). *Indo-Kazakhstan Civil Nuclear Agreement Report*. Government of India.

Ding, Y., Mallapragada, D., & Stoner, R. J. (2025). The role of coal plant retrofitting strategies in developing India's net-zero power system: A data-driven sub-national analysis. *Energy for Sustainable Development*, 86, 101687.

Dubash, N. K. (Ed.). (2019). India in a warming world: Integrating climate change and development. Oxford University Press.

East Asia Forum. (2020, June 23). No market for Australian uranium in India. *East Asia Forum*. Retrieved August 4, 2025, from https://eastasiaforum.org/2020/06/23/ no-market-for-australian-uranium-in-india/

Economic Times. (2015, June 3). India to renew contract with Kazakhstan for uranium supply. *The Economic Times*. Retrieved August 4, 2025, from https://economictimes.indiatimes.com/news/politics-and-nation/india-to-renew-contract-with-kazakhstan-for-uranium-supply/articleshow/47962948.cms

Economic Times. (2019). *India, Kazakhstan in talks to renew deal with higher uranium imports*. https://economictimes.indiatimes.com/news/politics-and-nation/india-kazakhstan-in-talks-to-renew-deal-with-higher-uranium-imports/articleshow/68898103.cms

Elavarasan, R. M., Afridhis, S., Vijayaraghavan, R. R., Subramaniam, U., & Nurunnabi, M. (2020). SWOT analysis: A framework for comprehensive evaluation of drivers and barriers for renewable energy development in significant countries. *Energy Reports*, *6*, 1838-1864.

Embassy of India, Astana. (2025). *Annual Energy and Strategic Review*. Retrieved from https://indianembassyastana.gov.in

Ersin, B. Y. (2024). India's "Connect Central Asia Policy" within the Context of the International North− South Transport Corridor. In *India's Economic Corridor Initiatives* (pp. 136-150). Routledge.

ETH Zurich, Center for Security Studies. (2008). *The Nuclear Suppliers Group waiver: Implications for India's nuclear policy* (GTZ report no. XX). ETH Zurich. Retrieved August 4, 2025, from https://www.files.ethz.ch/isn/92364/gtz08.pdf

Eurasia Daily Monitor. (2025). *Rosatom to build Kazakhstan's first nuclear power plant (Part Two)*. *Jamestown Foundation*. Retrieved from https://jamestown.org/program/rosatom-to-build-kazakhstans-first-nuclear-power-plant-part-two/

Eurasian Research Institute. (2017). *Latest developments in Kazakhstan's uranium industry*. Retrieved August 4, 2025, from https://www.eurasian-research.org/publication/latest-developments-in-kazakhstans-uranium-industry/

Eurasian Research Institute. (2020). *Energy Trends in Central and South Asia*. Almaty: ERI Publications.

Executive Agreements Database. (2022). *India-Kazakhstan Nuclear Cooperation Summary*. Retrieved from https://www.indianagreements.gov.in

Fernández-Arias, P., Lampropoulos, G., Antón-Sancho, Á., & Vergara, D. (2024). *Progress, challenges, and sustainable perspectives in nuclear energy strategies*. Applied Sciences, 14(24), Article 11864.

https://doi.org/10.3390/app142411864

Finnish Institute of International Affairs. (2023). *Russia and Kazakhstan in the global nuclear sector: From uranium mining to nuclear diplomacy*. Retrieved August 4, 2025, from https://fiia.fi/en/publication/russia-and-kazakhstan-in-the-global-nuclear-sector

Foreign Policy Research Institute. (2024). *China, Russia, and power transition in Central Asia.* https://www.fpri.org/article/2024/05/china-russia-and-power-transition-in-central-asia/

FT Editorial. (2025, June 16). *EU seeks to sever nuclear energy ties with Russia*. *Financial*

Times. Retrieved from https://www.ft.com/content/817fcc7a-ce50-4e4f-b85b-a27acc74a8cf

Fulton, J. (2025). *Building the Belt and Road Initiative in the Arab World: China's Middle East Math*. Taylor & Francis.

Ghosh, M. (2023). Growth and Development under Alternative Policy Regimes in India: A Political Economy Perspective. *Journal of Asian and African Studies*, 58(7), 1134-1155.

Government of India, Department of Atomic Energy. (2025). *Unstarred question No. 4230: Uranium imports* [Parliamentary reply]. https://cdnbbsr.s3waas.gov.in/s35b8e4fd39d9786228649a8a8bec4e008/uploads/2025/04/2025040210676799 99.pdf

Goyal, N. (2020). Promoting policy innovation for sustainability: Leaders, laggards and learners in the Indian electricity transition (Doctoral dissertation, National University of Singapore (Singapore)).

Grare, F. (2000). *The EU and Central Asia: Institutional Pathways for Energy Engagement*. Brussels: EU-INOGATE Initiative.

Grover, R. B. (2017). Opening up of international civil nuclear cooperation with India and related developments. Progress in Nuclear Energy, 101, 160-167.

Grozin, A. (2024). *India's Eurasian Energy Strategy: Risks and Opportunities*. Astana: Eurasian Policy Studies Institute.

Gupta, V., Sarkar, A., Deb, C., & Jana, A. (2025). Evaluating energy inefficiency in energy-poor households in India: A frontier analysis approach. arXiv preprint arXiv:2504.17056.

Hans, V. (2023). Multilateralism and India: Navigating global challenges through collaborative diplomacy. Multilateralism and India: Navigating Global Challenges Through Collaborative Diplomacy (December 2, 2023).

Hariharan, A. (2011). India's Nuclear Civil Liability Bill and Supplier's Liability: One Step Towards Modernizing the Outdated International Nuclear Liability Regime. *Wm. & Mary Envtl. L. & Pol'y Rev.*, *36*, 223.

Hibbs, M. (2015, February 6). *Tracking India's imported uranium*. Carnegie Endowment

for International Peace. Retrieved August 4, 2025, from https://carnegieendowment.org/2015/02/12/tracking-india-s-imported-uranium

Home, A. (2025, January 30). *Nuclear revival puts uranium back in the critical spotlight*. *Reuters*. Retrieved from https://www.reuters.com/markets/ commodities/nuclear-revival-puts-uranium-back-critical-spotlight-andy-home-2025-01-30/

Huda, M. S., & Ali, S. H. (2017). Energy diplomacy in South Asia: Beyond the security paradigm in accessing the TAPI pipeline project. *Energy research & social science*, 34, 202-213.

Hunt, K. M., & Bloomfield, H. C. (2025). Building and explaining data-driven energy demand models for Indian states. *Environmental Research: Energy*, 2(2), 025003.

Inchauste, G., & Victor, D. G. (2017). The political economy of energy subsidy reform. World Bank Publications.

Intellinews. (2024). *Russia and China maintain grip on Kazakhstan's uranium supply amid US and EU high reliance on it*. https://www.intellinews.com/russia-and-china-maintain-grip-on-kazakhstan-s-uranium-supply-amid-us-and-eu-high-reliance-on-it-307963/

International Atomic Energy Agency. (2023). *Kazakhstan and IAEA strengthen cooperation in nuclear technology and applications*. https://www.iaea.org/newscenter/news/kazakhstan-and-iaea-strengthen-cooperation-in-nuclear-technology-and-applications

International Atomic Energy Agency. (n.d.). *IAEA Low Enriched Uranium (LEU) Bank*. Retrieved August 13, 2025, from https://www.iaea.org/topics/iaea-low-enriched-uranium-bank

International Atomic Energy Agency. (2024). *Climate change and nuclear power 2024: Financing nuclear energy in low carbon transitions*. IAEA. https://doi.org/10.61092/iaea.sgyh-rjoq

International Energy Agency. (2024). *World Energy Outlook 2024*. Paris: IEA. https://www.iea.org/reports/world-energy-outlook-2024

International Energy Agency. (2025). *The path to a new era for nuclear energy*. IEA. https://www.iea.org/reports/the-path-to-a-new-era-for-nuclear-energy

Irfan, M., & Ojha, R. K. (2023). Foreign direct investment inflows and energy diversification in emerging seven economies: evidence from a panel data analysis. *International Journal of Emerging Markets*, 18(12), 5545-5564.

Jaiswal, M. (2018). *India-China Rivalry in Central Asia: Energy and Influence*. Delhi: Observer Research Foundation.

Jhalanim, K., Bose, A., & Rao, M. (2023). *Sustainable Energy Pathways for India: Policy Simulations and Forecasts*. Mumbai: TERI Press.

Ji, Z., & Sotnyk, I. M. (2023). Economic analysis of energy efficiency of China's and India's national economies.

Joint Declaration on Strategic Partnership between India and Kazakhstan. (2009, January 24). *Ministry of External Affairs, Government of India*. https://www.mea.gov.in/bilateraldocuments.htm?dtl/4776/Joint+Declaration+on+Strategic+Partnership+between+India+and+Kazakhstan

Joshi, P. (2000). *Russia and the Caspian Geopolitical Landscape*. Moscow: Russian Strategic Institute.

Kalyuzhnova, Y., & Holzhacker, H. (2021). Enhancing connectivity and trade between Central Asia regional economic cooperation countries and the world: Benefits, risks and policy implication (No. 1271). ADBI Working Paper Series.

Kazinform. (2026, May 3). *Foreign media on Kazakhstan: Oil shift, uranium deal, space ambitions*. Retrieved from https://qazinform.com/news/foreign-media-on-kazakhstan-oil-shift-uranium-deal-space-ambitions-567d9e on 27-08-2026.

Kassenova, T. (2010, May). Uranium Production and Nuclear Energy in Central Asia: Assessment of Security Challenges and Risks. In *China & Eurasia Forum Quarterly* (Vol. 8, No. 2).

Kassenova, T. (2024). Kazakhstan's Irreversible Disarmament. *Journal for Peace and Nuclear Disarmament*, *7*(1), 60–70. https://doi.org/10.1080/25751654.2024.2354951

Kathuria, V., & Natarajan, R. R. (2022). What Role Has Structural Change Played in Growth Accelerations for the Indian States? An Analysis for Pre-and Post-

liberalization Periods. *South Asia Economic Journal*, 23(1), 61-85.

Kaulgud, M. V. (2022). India-Central Asia Energy Relations: Prospects and Barriers. *Social and Political Research Foundation (PRF. IN)*.

Kazatomprom. (2024). *2023 financial results*. https://www.kazatomprom.kz/en/media/view/finansovie_rezultati_ao_nak_kazatomprom_za_2023_god

Kazatomprom. (2024, October 31). *3Q24 operations and trading update*. NAC Kazatomprom JSC. https://www.kazatomprom.kz/en/media/view/3Q24_operations_and_trading_update

Kazatomprom. (2025). *Integrated annual report 2024*. https://www.kazatomprom.kz/storage/b6/kap_iar_2024_eng_publication.pdf

Keohane, R. O. (1977). Power and Interdependence: World Politics in Transition. TBS The Book Service Ltd.

Keohane, R. O., & Nye Jr, J. S. (1973). Power and interdependence. *Survival*, *15*(4), 158-165.

Khan, K. (2025). How do supply chain and geopolitical risks threaten energy security? A time and frequency analysis. *Energy*, 134501.

Khan, K. H., & Koch, H. (2024). 'INSTC and Chabahar Port': An introduction. In *India's economic corridor initiatives* (pp. 3-19). Routledge.

Khosla, V. (2010). *Soft Power and Pipeline Politics in Central Asia*. New York: Brookings Institution.

Knar, E. (2024). Homeopathic Modernization and the Middle Science Trap: conceptual context of ergonomics, econometrics and logic of some national scientific case. *arXiv preprint arXiv:2411.15996*.

Kothari, R. K. (2020). India's Strategic Interests In Central Asia. World Affairs: *The Journal of International Issues*, 24(1), 100-117.'

Kospanov, R., & Gusseinov, E. (2026, May 28). *Uranium industry emerges as strategic bridge between India and Central Asia*. Geopolitical Monitor. Retrieved from https://www.geopoliticalmonitor.com/uranium-industry-emerges-as-strategic-bridge-between-india-and-central-asia/ on 27-08-2026.

Kulkarni, S., & Katti, R. (2012). *Economic Modelling of India's Energy Mix*. Pune: Indian School of Energy Economics.

Kumar, M. (2025). Reclaiming the Shakya Lineage: Buddhist Youth and Memory at Sankisa in Uttar Pradesh (Doctoral dissertation, University of British Columbia (Okanagan).

Kumar, S., & Aggarwal, A. (2020). *India's Act East and Nuclear Diplomacy*. New Delhi: Centre for Strategic Energy Studies.

Kurian, A. L. (2020) India's Energy Diplomacy in Central Asia: Challenges and Opportunities.

Kushwaha, R. P., & Verma, S. S. (2021). India's Energy Diplomacy Towards Central Asia. *Shodh Sarita*, 8(29), 243-248.

Laldjebaev, M., Isaev, R., & Saukhimov, A. (2021). Renewable energy in Central Asia: An overview of potentials, deployment, outlook, and barriers. *Energy Reports*, 7, 3125-3136.

Lansing Institute. (2024). *Kazakhstan's multi-vector foreign policy: Strategic balancing in a changing geopolitical environment*. https://lansinginstitute.org

Li, F., Yang, C., Li, Z., & Failler, P. (2021). Does geopolitics have an impact on energy trade? Empirical research on emerging countries. *Sustainability*, *13*(9), 5199.

Long, X., Chen, B., Dai, M., Xie, H., Chen, P., Meng, J., & Wang, Y. (2025). *Ambitious climate targets can make the phaseout of India's coal-fired power plants cost-beneficial*. Nature Communications. https://doi.org/10.1038/s41467-025-66580-4

Luhaniwal, J., Agarwal, S., & Mathur, T. (2025). *An integrated DEA-fuzzy AHP method for prioritization of renewable energy sources in India*. Scientific Reports, 15, Article 838. https://doi.org/10.1038/s41598-024-84891-2

Mackinder, H. J. (2017). The geographical pivot of history. In *The Structure of Political Geography* (pp. 162-169). Routledge.

Mackinder, H. J. (2017). The geographical pivot of history. In *The Structure of Political Geography* (pp. 162-169). Routledge.

Mahalingham, K. (2004). *India and the New Pipeline Geopolitics*. Delhi: South Asia Analysis Group.

Malhotra, A., Mathur, A., Diddi, S., & Sagar, A. D. (2022). Building institutional capacity for addressing climate and sustainable development goals: Achieving energy efficiency in India. *Climate Policy*, 22(5), 652-670.

Malhotra, A., Schmidt, T. S., Haelg, L., & Waissbein, O. (2017). Scaling up finance for off-grid renewable energy: The role of aggregation and spatial diversification in derisking investments in mini-grids for rural electrification in India. *Energy Policy*, 108, 657-672.

Mauro, M. R. (2024). *Energy security, energy transition, and foreign investments: An evolving complex relationship*. Laws, 13(4), Article 48. https://doi.org/10.3390/laws13040048

May, C. (1996). Strange fruit: Susan Strange's theory of structural power in the international political economy. Global Society: *Journal of Interdisciplinary International Relations*, 10(2), 167-189.

Mehta, K., Ehrenwirth, M., Trinkl, C., Zörner, W., & Greenough, R. (2021). The energy situation in Central Asia: A comprehensive energy review focusing on rural areas. *Energies*, 14(10), 2805.

Mehta, R. (2019). *Operational Challenges in Indo-Kazakh Energy Deals*. New Delhi: Indian Foreign Policy Review.

MiningSee. (2024). *Unlocking the dynamics: China's adaptive strategies in Kazakhstan's nuclear energy and uranium mining*. Retrieved from https://www.miningsee.eu/miningsee-world-china-kazakhstan-nuclear-energy-uranium-mining/

Mining-Technology. (2024). *Uranium in Kazakhstan*. https://www.mining-technology.com/data-insights/uranium-in-kazakhstan/

Ministry of External Affairs, Government of India. (2009). *Indo-Kazakhstan Strategic Engagement*. Retrieved from https://mea.gov.in

Ministry of External Affairs, Government of India. (2023). *Annual Energy Trade Bulletin*. Retrieved from https://mea.gov.in

Ministry of Statistics and Programme Implementation. (2023). *Energy Statistics Report 2023*. Government of India.

Mohan, P., & Agarwal, P. (2019). India's civil nuclear agreements: A new dimension in India's global diplomacy. *ORF Issue Brief*, *320*(2).

Mohan, R. (2009). *Energy and Diplomacy: India's Policy Strategies in the Global Arena*. Hyderabad: Orient BlackSwan.

Momin, R. (2023). Physics-Driven Cost Optimization and Advanced Research & Development (R&D) Strategies for Small Modular Reactors (SMRs) in Leading Nuclear Energy Nations. *arXiv preprint arXiv:2307.12989*.

Movkebaeva, G. A., & Sadvakassova, A. M. (2021). Cooperation between India and Central Asia and its importance for the region. *Bulletin of Karaganda University Series History*. Philosophy, 102 (2), 98-106.

MP, R. M. (2014). Nuclear liability law of India: an appraisal of extent of liability, right of recourse and transboundary applicability. *Journal of Risk Research*, *17*(1), 115-131.

Muhammad Amir, R., & Zeler, I. (2024). *Discourses on the sustainability of nuclear energy: A semi-systematic literature review of scientific production*. Discover Sustainability, 5, Article 503. https://doi.org/10.1007/s43621-024-00596-6

Muratbekova, A. (2017). From Asia to Eurasia: China and India interests in Central Asia. *Вестник КазНУ. Серия международные отношения и международное право*, *77*(1), 18-27.

Muratbekova, A. M., & Khitakhunov, A. A. (2024). India's Foreign Policy in Kazakhstan: Analysis of Cooperation Potential. *International Relations & International Law Journal/Seriâ Meždunarodnye Otnošeniâ & Meždunarodnoe Pravo*, 105(1).

Naik, H., & Srinivasan, S. (2014). The Civil Liability for Nuclear Damage Act, 2010: Is Promptness without Adequacy an Effective Remedy. *Law Rev. Gov't LC*, *8*, 57.

National Atomic Company Kazatomprom. (2025). *Integrated annual report 2024*. Kazatomprom. https://www.kazatomprom.kz/storage/d2/kap_iar_2024_eng_3004_clean2.pdf

NEA (2025), Uranium 2024: Resources, Production and Demand, OECD Publishing, Paris https://www.oecd-nea.org/jcms/pl_103179/uranium-2024-resources-production-and-demand?details=true

Nuclear Threat Initiative. (2023). *Kazakhstan's nuclear disarmament legacy*. NTI Country

Spotlight. Retrieved August 4, 2025, from https://www.nti.org/analysis/articles/kazakhstan-nuclear-disarmament/

NucNet. (2022, April 6). *Government says it has imported uranium from Kazakhstan, Canada and Russia*. Retrieved August 4, 2025, from https://www.nucnet.org/news/government-says-it-has-imported-uranium-from-kazakhstan-canada-and-russia-4-3-2022

OECD Nuclear Energy Agency, & International Atomic Energy Agency. (2025). *Uranium 2024: Resources, production and demand*. OECD Publishing. https://www.oecd-nea.org/upload/docs/application/pdf/2025-04/7683_uranium_2024_-_resources_production_and_demand_2025-04-22_14-29-2_928.pdf

Olcott, M. B. (2010). *Kazakhstan: unfulfilled promise*. Carnegie Endowment.

Ospanova, G., Mazalov, I., & Alybayev, Z. (2008). Mining of uranium in Kazakhstan. In *Uranium, Mining and Hydrogeology* (pp. 59-66). Berlin, Heidelberg: Springer Berlin Heidelberg.

Pan, Y. (2024, March 26). *To secure Kazakhstan's uranium, Chinese players were compelled to accommodate local partners*. Carnegie Endowment for International Peace. https://carnegieendowment.org/posts/2024/07/to-secure-kazakhstans-uranium-chinese-players-were-compelled-to-accommodate-local-partners

Pandey, J. G., & Kumar, A. (2025). Navigating India's energy transition: A systematic literature review of risks in the coal phase-down process. *Renewable and Sustainable Energy Reviews*, 210, 115260.

Pant, H. V. (2004). *US Strategic Interests in the Caspian Region*. New Delhi: Institute of Peace and Conflict Studies.

Pardesi, M. S., & Ganguly, S. (2020). India and energy security: A foreign policy priority. In Indian foreign policy in a unipolar world (pp. 99-127). Routledge India.

Patnaik, S. (2010). *China vs. India in Central Asia: A Diplomatic Comparison*. New Delhi: Observer Research Foundation.

Paul, T. V. (2024). The unfinished quest: India's search for major power status from Nehru to Modi. Oxford University Press.

Pradhan, R. (2020). Energy geopolitics and pipeline diplomacy in Central Asia: India's

interests and policy options. *Jadavpur Journal of International Relations*, 24(2), 216-246.

Pradhan, R. (2020). Geopolitics of Energy in Central Asia: India's Position and Policy. Routledge India.

Pradhan, R. (2022). Energy geopolitics and the new great game in Central Asia. *Millennial Asia*, *13*(2), 265-288.

Pradhan, R. (2022). India-Kazakhstan energy relations: Looking back and looking ahead. *Journal of Eurasian Studies*, 13(2), 103-118.

Pradhan, R. (2022). India-Kazakhstan energy relations: Looking back and looking ahead. *Journal of Eurasian Studies*, *13*(2), 103-118.

Prajapati, P., Guo, R., Cai, A., & Prasad, R. (2025). Navigating the energy transition in India: Challenges and opportunities towards sustainable energy goal. *Water-Energy Nexus*. https://doi.org/10.1016/j.wen.2025.07.004

Press Information Bureau, Government of India. (2023, April 6). *Major findings of research institutes under DAE: Capabilities across nuclear science, power, and R&D fields*. Press Information Bureau. Retrieved August 4, 2025, from

Press Information Bureau. (2025). *India's Nuclear Roadmap 2047*. Government of India. Retrieved from https://pib.gov.in

Raizada, S., Sharma, D., Laan, T., & Jain, S. (2024). Mapping India's Energy Policy 2023.

Raj, K., & Sharma, D. (2024). Effects of energy price shock on the macroeconomic indicators of India: a new measure. *International Journal of Energy Sector Management*, 18(6), 1787-1812.

Rao, K. P. (2018). A study on India and central asia relations through the eye of energy politics. *ZENITH International Journal of Multidisciplinary Research*, 8(2), 75-85.

Rao, N. D., & Pachauri, S. (2017). Energy access and living standards: some observations on recent trends. *Environmental Research Letters*, 12(2), 025011.

Rathi, A., & Bansal, V. (2020). *Public Perceptions of India-Kazakhstan Nuclear Cooperation*. Mumbai: Indian Social Research Journal.

Rentschler, J., & Bazilian, M. (2017). Reforming fossil fuel subsidies: drivers, barriers and

the state of progress. Climate Policy, 17(7), 891-914.

Reuters. (2024). *Kazakhstan votes in favour of nuclear power plant construction, exit poll shows*. https://www.reuters.com/world/asia-pacific/kazakhstan-votes-whether-build-first-nuclear-plant-2024-10-06/

Reuters. (2024). *Red Sea Shipping Crisis and Global Oil Prices*. Retrieved from https://www.reuters.com

Reuters. (2025). *India Considers Nuclear Liability Reform to Attract FDI*. Retrieved from https://www.reuters.com

Sage Journals. (2022). *India's Foreign Policy in a Multipolar World*. Sage Publications. Retrieved from https://journals.sagepub.com

Sajjanhar, A. (2009). *Civilizational Diplomacy in Indo-Kazakh Relations*. Indian Council of World Affairs Brief.

Sajjanhar, A. (2013). India-Kazakhstan relations: Challenges and opportunities. Indian Embassy in Kazakhstan.

Sajjanhar, A. (2013). India-Kazakhstan relations: Challenges and opportunities. *Indian Embassy in Kazakhstan*.

Sarkar, P. (2022). India's strategy of energy security in central Asia: a case study of Kazakhstan (1991-2020).

SC National Atomic Company Kazatomprom. (n.d.). *Annual reports (2018-2024)*. https://www.kazatomprom.kz/en/investors/godovie_otcheti

Selvam, D. C., Yuvarajan, D., Kumar, M. S., Shukla, K., Patel, C., Juneja, B., & Acharya, S. (2025). *Harnessing nuclear energy for India's energy security: Current status, challenges, and future opportunities*. https://www.sciencedirect.com/science/article/pii/S2590123025011806

Shah, P. (2013). *Pipeline Integration in South and Central Asia: A Regional Blueprint*. Lahore: South Asia Energy Forum.

Shannak, S. D., Cochrane, L., & Bobarykina, D. (2025). Global uranium market dynamics: analysis and future implications. *International Journal of Sustainable Energy*, *44*(1), 2457376.

Sharlapaev, K. (2025). *Kazakhstan as a critical partner in the age of critical raw materials: uranium and clean-energy geopolitics*. *The Geopolitics Journal*. Retrieved August 4, 2025, from https://thegeopolitics.com/kazakhstan-can-be-a-critical-partner-in-the-age-of-critical-raw-materials/

Sharma, V. (2023). Assessing the Viability of India's Nuclear Liability Law in the Current Context: Key Issues and Challenges. *Jus Corpus LJ*, *4*, 750.

Siddi, M., & Silvan, K. (2023). Russia and Kazakhstan in the global nuclear sector: From uranium mining to energy diplomacy.

Siddiky, C. I. A. (2021). The geopolitics of energy in South Asia: Energy security of Bangladesh. Routledge.

Singh, H. (2015). Indo-Kazakhstan Nuclear Partnership Agreement. *Journal of Central Asian Studies*, *22*, 119-126.

Singh, H. (2015). Indo-Kazakhstan nuclear partnership agreement. *The Journal of Central Asian Studies, 22*(1), 119-126. University of Kashmir. https://ccas.uok.edu.in/Files/93269b6c-7f53-4439-ae9a-3bdf55a4c649/Journal/630203f5-8f37-44bb-b329-2e8edcf74a9f.pdf

Singh, K., Meena, R. S., Kumar, S., Dhyani, S., Sheoran, S., Singh, H. M., ... & Byun, C. (2023). India's renewable energy research and policies to phase down coal: Success after Paris agreement and possibilities post-Glasgow Climate Pact. *Biomass and Bioenergy*, 177, 106944.

Singh, R. (2010). *India's Energy Security: Challenges and Policy Options*. New Delhi: Academic Foundation.

Singh, S., & Kaur, A. (2014). Connect central asia policy'factor in India's soft power initiatives in cars: problems and prospects. *International Journal of Advanced Research in Management and Social Sciences*, 3(12), 94-114.

Singh, V. (2016). *Nuclear Energy Diplomacy and India's Strategic Outlook*. New Delhi: Anamika Publishers.

Smagulova, A., Khamzayeva, A. V., Myrzachmetvoa, A. M., Yerimpasheva, A., & Bekmukhametova, A. B. (2025). Economic transformation and environmental impact in Central Asia: a case study of Kazakhstan's shift to renewable energy.

International Journal of Energy Economics and Policy, *15*.

Sobha, P. (2022, January). Decarbonizing Indian Electricity Grid. In *International Conference on Electrical and Electronics Engineering* (pp. 312-322). Singapore: Springer Nature Singapore.

Sovacool, B. K. (2017). Reviewing, reforming, and rethinking global energy subsidies: towards a political economy research agenda. *Ecological Economics*, 135, 150-163.

Squassoni, S. (2010). *The U.S.–Indian deal and its impact*. *Arms Control Today*, (July/August), n.p. Arms Control Association. Retrieved August 4, 2025, from https://www.armscontrol.org/act/2010-07/us-indian-deal-and-its-impact

Srivastav, A. (2020). Energy security and sustainability: an overview. *Energy Dynamics and Climate Mitigation*: An Indian Perspective, 1-31.

Stanford University. (2010). *Uranium mining in Kazakhstan and pervasive state participation*. Retrieved August 4, 2025, from http://large.stanford.edu/courses/2010/ph240/sagatov1/docs/Uranium_Mining.pdf

Strange, S. (1994). States and Markets, 2nd edn (London: Pinter). *Strange2States and Markets1994*.

Strange, S. (1996). *The retreat of the state: The diffusion of power in the world economy*. Cambridge university press.

Strange, S. (2015). Casino capitalism. In *Casino capitalism*. Manchester University Press.

Sulaimanova, L. (2023). *Kazakhstan's Energy Transition and External Partners*. Almaty: Nazarbayev University Press.

Supyaldiyarov, A. (2024). *Strategic Dimensions of Central Asian Nuclear Diplomacy.* Astana: Eurasian Policy Studies Institute.

Tellis, A. J. (2006). Atoms for War? US-Indian civilian nuclear cooperation and India's nuclear arsenal.

Tellis, A. J. (2023). Completing the US-India Civil Nuclear Agreement: Fulfilling the Promises of a Summer Long Past.

The Diplomat. (2024). *In Russia-U.S. uranium split, an opportunity for Kazakhstan*.

https://magazine.thediplomat.com/2024-06/in-russia-us-uranium-split-an-opportunity-for-kazakhstan

The Moscow Times. (2025). *Rosatom to build Kazakhstan's first nuclear power plant*. Retrieved from https://www.themoscowtimes.com/2025/06/14/rosatom-to-build-kazakhstans-first-nuclear-power-plant-a89447

Tongia, R. (2022). Balancing India's 2030 electricity grid needs management of time granularity and uncertainty: insights from a parametric model. *Transactions of the Indian National Academy of Engineering*, 7(4), 1127-1150.

Trading Economics. (2025). *India imports from Kazakhstan of uranium or thorium ores and concentrates*. Retrieved August 4, 2025, from https://tradingeconomics.com/india/imports/kazakhstan/uranium-thorium-ores-concentrates

Trading Economics. (2025). *Uranium*. Trading Economics. Retrieved August 4, 2025, from https://tradingeconomics.com/commodity/uranium

Trend News Agency. (2024). *Kazakhstan's national uranium company sums 2023 with fall in output*. https://en.trend.az/casia/kazakhstan/3856938.html

Tumanshiyev, D., Isova, L., & Abduali, M. (2024). Geopolitical significance of Kazakhstan's uranium reserves in the global security system. *International Relations and International Law Journal* , *108* (4), 4-13. https://doi.org/10.26577/IRILJ.2024.v108-i4-a1

Tumanshiyev, K., Bekenov, R., & Dugalov, S. (2024). *Eurasian Energy Cooperation and Non-NPT Nuclear Engagements*. Astana: Center for Strategic Research.

Umarov, K. (2009). *Indo-Kazakh Relations in the Post-Cold War Era*. Almaty: Kazakhstan Academy of International Studies.

Vanderhill, R., Joireman, S. F., & Tulepbayeva, R. (2020). Between the bear and the dragon: multivectorism in Kazakhstan as a model strategy for secondary powers. *International affairs*, *96*(4), 975-993.

Wæver, O. (1995). Securitization and Desecuritization. On Security. *Ed. Ronnie D. Lipschutz. NY: Columbia University Press [in English]*.

Wani, A. (2024). The Chabahar Gambit: India's Play for Influence in Central Asia.

Weitz, R. (2014). Kazakhstan's Developing Non-Proliferation Goals, Opportunities, and

Challenges. *Middle East Institute*. Retrieved August 4, 2025, from https://www.mei.edu/sites/default/files/Weitz_Kazakhstan.pdf

World Nuclear Association. (2023). *Uranium Production by Country – 2023 Review*. Retrieved from https://world-nuclear.org

World Nuclear Association. (2024). *World uranium mining production*. Retrieved August 4, 2025, from https://world-nuclear.org/information-library/nuclear-fuel-cycle/mining-of-uranium/world-uranium-mining-production

World Nuclear Association. (2025). *Uranium and nuclear power in Kazakhstan*. https://www.world-nuclear.org/information-library/country-profiles/countries-g-n/kazakhstan

World Nuclear Association. (2025). *World uranium mining production*. https://world-nuclear.org/information-library/nuclear-fuel-cycle/mining-of-uranium/world-uranium-mining-production

World Nuclear Association. (2026, July 1). *Uranium and nuclear power in Kazakhstan*. Retrieved from https://world-nuclear.org/information-library/country-profiles/countries-g-n/kazakhstan on 28-08-2026.

World Nuclear News. (2011). *Kazakhstan Signs Uranium Deal with India*. Retrieved from https://world-nuclear-news.org

World Nuclear News. (2011, April 15). *India–Kazakhstan nuclear cooperation agreement signed*. World Nuclear Association. Retrieved August 4, 2025, from https://www.world-nuclear-news.org/Articles/India-Kazakhstan-nuclear-cooperation-agreement-sig

World Nuclear News. (2022). *Indian minister provides uranium, construction updates*. https://www.world-nuclear-news.org/Articles/Indian-minister-provides-uranium%2C-construction-upd

World Nuclear News. (2022, April 5). *Indian minister provides uranium, construction updates*. Retrieved August 4, 2025, from https://www.world-nuclear-news.org/Articles/Indian-minister-provides-uranium%2C-construction-upd

World Nuclear News. (2025). *CGN set to take stake in Kazakh uranium-mining*

companies. Retrieved from https://www.world-nuclear-news.org/Articles/ CGN-set-to-take-stake-in-Kazakh-uranium-mining-com

World Nuclear News. (2025). *Kazatomprom sets out strategy for next 10 years*. https://www.world-nuclear-news.org/Articles/Kazatomprom-sets-out-strategy-for-next-10-years

Zohuri, B. (2023). Evolving National Security: A Roadmap from Present to Future in Renewable and Nonrenewable Energy Policies (A Technical Review). *Journal of Energy and Power Engineering*, 17, 102-108.

ANNEXURE I
SEMI-STRUCTURED INTERVIEW SCHEDULE

Title: *India's Energy Vulnerability and its Nuclear Energy Policy Towards Central Asia Since 1991: A Study of Kazakhstan*

SECTION A: SOCIO-DEMOGRAPGHIC PROFILE OF RESPONDENTS

Name (Optional)	
Age (in Years)	25–35 / 36–45 / 46–55 / 56+
Gender	Male / Female / Other
Education	Postgraduate / M.Phil. / PhD / Other:
Designation	
Area of Expertise	Energy Policy / Nuclear Studies / International Relations / Academia / Other
Organization/Institution	
Years of Experience	<5 / 5–10 / 10–20 / 20+
Country of Work/Engagement	
Experience Related to Central Asia / Kazakhstan	Yes / No (If Yes: Specify)

SECTION B: SEMI-STRUCTURED INTERVIEW QUESTIONS

Theme 1: India's Energy Vulnerability

Question	**Response**
How do you assess the current state of India's energy vulnerability, particularly in terms of import dependence?	
What are the key structural challenges affecting India's energy security today?	

Theme 2: Role of Nuclear Energy

Question	Response
In your opinion, how significant is nuclear energy in achieving India's long-term energy security goals?	
What are the major policy and institutional constraints limiting the growth of nuclear energy in India?	

Theme 3: Strategic Importance of Central Asia

Question	Response
How do you evaluate the importance of Central Asia, especially Kazakhstan, in India's energy diplomacy?	
What opportunities does Kazakhstan offer in terms of uranium supply and nuclear cooperation?	

Theme 4: Indo–Kazakhstan Nuclear Cooperation

Question	Response
How effective has the 2011 Indo–Kazakhstan Civil Nuclear Agreement been in strengthening India's energy security?	

What are the key challenges or limitations in the implementation of this partnership?	

Theme 5: Geopolitical and Logistical Constraints

Question	**Response**
How do geopolitical factors such as China's influence and regional connectivity issues affect India's engagement with Kazakhstan?	
To what extent do logistical barriers (e.g., lack of direct connectivity) hinder energy cooperation?	
Any Other Challenge	

Theme 6: Policy Recommendations and Future Prospects

Question	**Response**
What strategies should India adopt to enhance nuclear cooperation with Kazakhstan and Central Asia?	
How can India strengthen its energy diplomacy and strategic presence in the region in the coming decades?	

What policy reforms would you prioritize?	

SECTION C: SUSTAINABILITY IN ENERGY AND NUCLEAR POLICY

Question	**Response**
How do you assess the role of nuclear energy as a sustainable long-term solution for meeting India's growing energy demand?	
In your view, to what extent can the expansion of nuclear energy contribute to reducing carbon emissions in India's energy mix?	
How effectively does India's current nuclear energy policy address environmental sustainability concerns?	
Do you think achieving sustainable energy security requires a balanced integration of nuclear and renewable energy sources? Please explain.	
How does long-term cooperation with Kazakhstan influence the sustainability of India's nuclear fuel supply?	
What is the importance of nuclear safety, waste management, and regulatory frameworks in ensuring sustainable nuclear energy development in India?	

Thank you for your valuable insights. Your responses will be used strictly for academic research purposes and confidentiality will be maintained.

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Energy Corridors and Regional Planning: India's Energy Security and Nuclear Cooperation with Kazakhstan

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Abstract:
Thanks to rising incomes and improving living standards, India is emerging as the world's third-largest energy consumer. Since 2000, energy use has nearly doubled, with coal, oil, and solid biomass meeting about 80% of demand, making energy a strategic sector of the national economy. In the early decades after independence, energy received little attention due to a socialist policy focus. However, the 1973 oil crisis marked a turning point, highlighting the direct link between economic growth and energy demand. According to Energy Statistics 2018, India, with 17.7% of the world's population, has only 0.27% of known oil and natural gas resources, indicating a severe supply-demand gap. Post-1991 liberalization, India sought to address this gap through foreign policy and economic diplomacy initiatives such as the Look East, West Asia, and Look North policies. India Energy Outlook 2021 projects oil demand will double to 11 million barrels per day by 2045, while natural gas consumption will grow by 25 billion cubic meters. This rising demand has spatial consequences, with consumption concentrated in industrial corridors, metropolitan regions, and transport networks, necessitating regionally coordinated infrastructure planning. Meeting future needs requires exploring new energy frontiers and designing cross-border connectivity strategies. Central Asia, with its abundant resources, landlocked geography, and proximity to India, offers a viable option. Integrating it through planned energy and transport corridors would not only enhance supply security but also support broader territorial development, regional connectivity, and sustainable growth objectives.

2.1 Introduction

India's energy security has transformed from a sectoral policy concern into a multidimensional strategic imperative, **demanding sophisticated national planning and robust institutional architecture (**Bhattacharya, 2022**).** With the country's economic rise, accelerated urbanization, and geopolitical aspirations in the post-liberalization era, energy is no longer viewed simply in terms of resource adequacy but rather through the prisms of sustainability, sovereignty, and resilience (Chatterjee, 2024). Energy security refers to the uninterrupted availability of energy sources at an affordable price. It encompasses four key dimensions: availability, accessibility, affordability, and acceptability. For India, energy security is not just about preventing blackouts or import shortages; it is tied to developmental sovereignty, economic growth, and national security, **requiring long-term, integrated planning across diplomatic, economic, and infrastructure sectors (**Aggarwal, n.d.**).** As the country's import dependence on oil (over 85%), gas, and uranium intensifies, the ability to secure stable and diverse energy partnerships becomes vital for sustaining strategic autonomy, **making supply chain planning a critical component of national strategy.**

India has undergone an energy consumption structure that has never been seen before, triggered by the economic reforms that started in 1991 (Dubash, 2019). The process of liberalization led to the development of the industry, the expansion of infrastructure, and the spread of electricity to households, all of which caused a boom in hydrocarbon dependence. **This paradigm shift necessitated the design of new regulatory frameworks and an aggressive infrastructure planning schedule to manage the resultant demand surge and consumption shift.** According to Srivastav (2020), the energy elasticity of India is still high compared to the international standards, which shows the extent to which economic performance is linked to energy consumption. Despite aggressive renewable energy goals, fossil

fuels remain influential with coal accounting the highest percentage of electricity generation. The Indian energy policy of 2023, in its turn, as concluded by Raizada et al., remains based on coal as a baseload energy source as it is important and tries to increase the number of solar and wind power (2024). In the meantime, Malhotra et al. (2017) observe that the rest of the derisking gaps in financing off-grid renewable solutions, such as mini-grids, are the barrier to electrifying the rural and under-served regions. Such loopholes are symptomatic of failure of a financial planning and policy tool that would be necessary to successfully mobilize private capital to decentralized development.

These vulnerabilities of the Indian energy system cannot be reduced to the scarcity of the supply only; it concerns the impossibility of the system to plan in advance against climate and economic pressures. Agarwal et al. (2024) reveal how the Chennai floods caused significant shocks in the energy access to the urban poor population because of price and income shocks, and how the effect also explains the vulnerability of consumption in the context of the disaster in place. This demonstrates that the geographical vulnerability factors will have to be incorporated in the energy planning systems because they include flood-prone urban areas, infrastructure being exposed to the coastal region, and local climate patterns. It highlights the significance of having local-level disaster planning and beautiful energy supply continuity measures. At the national level, the rise in demand reaches its peak and the process of decarbonization is more problematic in terms of the electricity grid functioning. Tongia (2022) identifies the management of demand volatility and granularity as one of the key challenges in the 2030 electricity system of India as it increases the use of intermittent renewable sources. Addressing this requires extensive planning for smart grid deployment, predictive modeling, and regulatory mechanisms to incentivize distributed energy resources. Barbar et al. (2023) highlight how energy storage forms critical infrastructure to stabilize the grid against instability and provide dispatch flexibility in a high-renewables future. Therefore, the deployment of energy storage systems is a crucial element of the nation's technical infrastructure development plan.

In sum, India's energy security strategy is evolving beyond resource procurement to embrace a spatially grounded planning paradigm one that links geography, infrastructure, and development policy to ensure resilient, equitable, and strategically positioned energy systems.

2.2 The Political Economy of Energy in Post-Liberalized India

The energy scenario in India has witnessed a sea change since the economic liberalization started in the year 1991. A new political economy of energy was signified by the replacement of a Nehruvian paradigm of self-sufficient socialist planning with a market-based model of energy governance (Malhotra et al., 2022). The new interaction of economic liberalization, political interests, strong institutional structures to implement and international contingencies in the production of energy policies and their implementation is political economy in this context. The state monopoly, which provides energy, was substituted with the hybrid mode of governance, in which the predominance of the existence of the public sector is accompanied by the increasing participation of the private, and foreign sectors (Ghosh, 2023; Chatterjee, 2017). This change necessitated a radical redesign of the regulatory planning process, repercussions of a centralized bureaucratic control to decentralized and market-driven control.

It is one of the typical changes which took place in the post liberalized India, the liberalization of the energy sector to foreign direct investment (FDI). This policy change allowed foreign involvement in the fields that were pretty much needed like renewable energy source generation plants, oil exploration and power transmission. It helped in diversifying the energy and avoiding overreliance on coal, which led to the transfer of technology as it is disclosed by Irfan and Ojha (2023). This policy needed to be effectively implemented through careful planning of FDI incentives, simplified regulatory approvals and supportive infrastructure development (e.g. special transmission corridors) to accommodate the new investment. However, as it is stated in the article by Singh et al. (2023), the fact that India has established climate targets in the Paris climate agreement and the Glasgow Climate Pact also triggered this process, and specifically the renewable energy sector, also triggered this process. These international obligations directly become domestic planning obligations where a formal, quantified policy roadmap is necessary, to phase-down coal and to expedite the building of renewable capacity. This restructuring around energy liberalization, or in other words the deregulation and privatization of energy markets, which put India in the role of an up-and-coming actor in the global energy transition.

Liberalization has however not been even spread across the entire country. According to Goyal (2020), some Indian states are much better placed to undertake innovation and transition to investment and energy than others. By example, Gujarat and Tamil Nadu have led the pack in embracing renewable sources and other states are in the rut of

the old systems. This nonhomogeneity highlights one of the greatest flaws of national-level planning and implementation of best practices that are uniform. Such an imbalance is indicative of the fact that Indian energy institutions are entrenched in path dependency - in which the past of policy prefigures the current governance capacity to move to new forms of governance by institutional inertia and lock-in to infrastructure (Kathuria and Natarajan, 2022). This has to be defeated by a state specific developmental strategy that addresses any legacy debt and designs incentive structure to be institutionally responsive.

Although the politics of liberalization, subsidies and structural powers have influenced the political economy of energy transition in India, the changes, which are being experienced in institutions, must be analyzed, and the material pressures that are being generated in the domestic sphere. The ever-increasing energy demand-supply mismatch especially with the accelerated urbanization, industrialization and population explosion has only contributed to the even greater urgency of the necessity to re-optimize the Indian energy mix (Kumar, 2025). Thus, the need to reform domestic energy consumption pattern, sector requirements, and technological bottlenecks require the growing awareness of the long-term, integrated planning solutions in the way that the logic behind the diversification policies, and in particular the growing role of renewable, natural gas, and nuclear energy could be better perceived as planned responses to mitigate systemic risk and preserve sustainable national development.

2.3 Mapping India's Energy Demand-Supply Framework

The period of post liberalization has changed the energy situation of India significantly on the basis of the structure limitation and pattern of consumption of the various sectors and also the changing paradigm of technology. At the start of the 1990s, national energy consumption was about 5.8 exajoules, and, in line with the process of industrialization, urbanization, and the expansion of the middle class with the consumption-oriented culture, it increased correspondingly (Barbar et al., 2021; Hunt and Bloomfield, 2025). Beneath this abrupt surge in demand lies a deeper vice which is the rigidity on the supply-side, and the one-sided institutional changes that bring to fore an important gap in adaptive long-term development planning.

Sector wise, the industrial sector has been the largest user of energy since it contributes over 40 percent of commercial energy use in India. The drivers of its growth are its core industries including steel, cement, and chemicals, which are energy-intensive in nature and mostly rely on coal. The residential sector by contrast shows a paradox of increasing electrification and energy poverty. Even with better grid penetration, millions of homes still have inefficient appliances, and they pay high per-unit energy charges due to the lack of proper insulation, infrastructure, and regular power supply (Gupta et al., 2025). **This suggests a failure in integrating energy efficiency mandates and smart distribution planning into urban development projects.** Spatial inequality is reinforced by the fact that energy poverty is acute in rural areas and peri-urban areas.

Agricultural energy consumption presents another complexity. Although initiatives like solar pump programs and subsidized power schemes have been introduced, the sector remains heavily dependent on diesel, particularly for irrigation during peak cropping seasons. **The lack of a comprehensive, planned transition strategy beyond subsidies prevents the systematic reduction of the national oil import burden.** These patterns inflate both environmental costs and national oil import burdens. The transport sector, similarly, has shown only marginal transitions towards electrification. India's vehicle fleet continues to be dominated by petroleum-based fuels, which form a significant component of the country's import bill. Despite policy efforts to promote electric mobility, infrastructural bottlenecks, behavioral resistance, and inadequate charging ecosystems impede large-scale adoption. **Effective planning requires a national charging infrastructure blueprint with detailed geographical targets, regulatory harmonization across states, and specific timelines for public transit fleet electrification.**

India's energy mix is emblematic of long-standing path dependencies. Coal continues to dominate, supplying more than 70% of electricity, a situation born of domestic reserves, entrenched industrial interests, and infrastructural inertia. The move to "phase down" rather than "phase out" coal, as advocated in international forums, reflects India's cautious balancing of environmental responsibility with economic and employment concerns (Pandey & Kumar, 2025). **This necessitates a detailed, quantitative planning roadmap for the phase-down, including state-wise capacity retirement plans and a financial strategy for managing stranded assets.** While renewable energy has made significant gains especially solar and wind their intermittent nature poses serious challenges to grid integration, particularly in states with outdated transmission infrastructure (Sobha, 2022; Tongia, 2022). **The planning failure here lies in the insufficient investment and execution of the national transmission system upgrade necessary to evacuate power from renewable-rich regions.**

Technological and policy-based responses to these challenges are still emerging. Energy storage systems

and smart grid technologies are touted as pivotal solutions for managing peak demand and variable supply. However, India's grid architecture and regulatory landscape are still not fully equipped to support high renewable penetration (Barbar et al., 2023). **Achieving full support requires an immediate revision of regulatory codes by planning bodies like the Central Electricity Authority (CEA) to standardize interconnection protocols and mandate technical specifications for utility-scale storage.** Initiatives such as retrofitting coal plants are a good idea but only work in certain industrial belts and are faced by funding and execution loopholes (Ding et al., 2025). The narrowness and inadequacy of financial planning in these projects highlights the necessity of a national capital expenditure plan that has milestones and specific public-private partnership models to be utilized.

2.4 Strategic Dimensions of Energy Security

The Indian paradigm of energy security is undergoing a paradigm shift in India, not only the traditional and limited sense of the physical availability of the energy resources, but the multidimensional sense of the availability which entails the affordability, reliability, sustainability and strategic independence. A good long-term national energy strategy is required in this change. The Indian economic climate in the post-liberalization era, along with the accelerating tendency of globalization, the need to change climate imperative, and the imbalance of powers between countries, have created a need to learn more about energy to consider it not as a development factor, but as national resources that can make or break economies, social welfare, and global politics (Bardhan et al., 2019). Current energy security issues facing India are the security of energy at constant levels or reduction of exposure to fluctuations in prices, environmental impact and technology availability of both traditional and renewable energy industries. These dimensions are too complex hence the need to coordinate the Ministries of External Affairs, Finance, and Power.

This is a broadened definition of energy security that is particularly acute in the light of the external interferences that periodically strike the energy supply lines of India. The fluctuations in the international oil markets, which were witnessed in the 2008 financial crisis, and, most recently, in the COVID-19 pandemic and the conflict in Ukraine, have demonstrated the instability of the economies which rely on imported energy supplies. Disruption of maritime trade in strategic chokepoints like the Strait of Hormuz has also been a weakness of India. The spark of the geopolitical turmoil and threat in the chain of supply, to which Khan (2025) indicated, is a concomitant factor in the short-term balance of the prices and long-term strategy of investment. Planning response to this vulnerability entails the quantified approach to resource diversification and creation of strategic petroleum reserves (SPRs) as well as planning investment in alternative transport corridors. Since more than 80 percent of crude oil is imported, India ranks as being highly exposed to such externalities, resulting in macroeconomic imbalance through inflation, currency devaluation and fiscal burden. These economic effects subsequently cascade down to the societal level, creating a strain on energy subsidies and increasing the energy poverty gap between the at-risk groups (Raj & Sharma, 2024).

In order to conceptually understand this energy priority in national security, the concept of securitization of energy has increasingly been employed by scholars. This theory has been constructed in the context of the Copenhagen School and is applied to conceptualize how political actors can package issues involved in energy as existential threats requiring extra-ordinary political and policy action. In India, the securitization of energy was brought into focus with the global oil shocks in the early 2000s and the 1991 Gulf War. These trends prompted a policy shift to hydrocarbon diplomacy, diversification of energy imports and a rise of institutional interest in energy policy. The switch of this policy mentality gave rise to the formulation of the special implementation and coordination organizations envisaged. Such an institutionalization of the energy security discourse can be traced in the establishment of ministries dedicated to energy security in particular, a Ministry of New and Renewable Energy (MNRE) and inter-ministerial energy coordination committees. The efficiency of such institutional planning, however, depends on the effective mandates, the effective allocation of resources and the smooth inter-agency coordination mechanisms. This formulation of energy as a security requirement is what allows states to mobilize energy and engage in policies that need not necessarily assume an economic explanation, such as diplomatic, military, and intelligence aspects (as elucidated in Zohuri, 2023).

2.5 Central Asia as a Strategic Energy Frontier

The geopolitical reorientation of Central Asia in the post-Cold War period has positioned the region as a critical strategic energy frontier a geographic area rich in yet underutilized resources that hold immense importance for external powers seeking to diversify energy sources and bypass vulnerable maritime routes. The five Central Asian republics Kazakhstan, Turkmenistan, Uzbekistan, Kyrgyzstan, and Tajikistan are endowed with abundant energy reserves: significant oil and natural gas deposits in Kazakhstan and Turkmenistan, extensive uranium resources in Uzbekistan and Kazakhstan, and vast

hydroelectric capacities in Kyrgyzstan and Tajikistan. These assets, long constrained by Soviet-era centralization and post-Soviet political fragmentation, are regaining prominence as the global energy paradigm pivots toward diversified, regional partnerships and resource-secure routes (Laldjebaev et al., 2021; Mehta et al., 2021). **This dynamic directly shapes India's strategic resource planning, necessitating the creation of comprehensive logistics and procurement plans to secure these assets.**

India's increasing interest in Central Asia represents a broader strategic realignment in its energy diplomacy, which refers to the use of diplomatic and foreign policy tools to secure reliable and long-term access to external energy resources and infrastructure. Historically, India's energy strategy was heavily dependent on West Asian nations primarily Saudi Arabia, Iran, and Iraq for crude oil and LNG. However, the region's growing instability, coupled with geopolitical risks like the Strait of Hormuz chokepoint and sanctions on Iran, have exposed India's vulnerability. In response, Central Asia emerges as a politically stable and land-connected alternative with the potential to fortify India's energy security defined as the uninterrupted availability of energy at affordable prices, including aspects of sustainability, reliability, and independence from monopolistic suppliers (Kaulgud, 2022; Rao, 2018). **The selection of Central Asia as a strategic partner is thus a deliberate outcome of a risk mitigation planning exercise aimed at diversifying India's supply portfolio.** Following the dissolution of the USSR in 1991, India initially lacked the diplomatic infrastructure and policy focus to meaningfully engage with the newly independent Central Asian republics. The geographic remoteness and absence of direct transit access further constrained early outreach. However, the intensifying presence of China through its Belt and Road Initiative (BRI) and the continued influence of Russia spurred India to act. Scholars such as Pradhan (2020) and Kurian (n.d.) argue that India's multi-alignment doctrine its foreign policy principle of engaging with multiple global powers without exclusivity is particularly salient in this context. Energy diplomacy thus becomes a lever through which India asserts strategic autonomy while building long-term continental partnerships. **This is achieved through formal policy planning mechanisms, such as the *Connect Central Asia Policy* (CCAP), which provides a structured institutional framework for engagement and implementation.**

Kazakhstan is the bedrock of nuclear energy diversification of India. Being one of the largest uranium producers in the world with almost 15 percent of the known global reserves it is central to securing nuclear fuel security in India, ensuring the steady and consistent supply of uranium required to fuel the growing nuclear power production of India. The factor has gained an added impetus following the Indo-U.S. civil nuclear agreement wherein, India has signed a formal uranium buying agreement with Kazatomprom, the national uranium power company of Kazakhstan (Rao, 2018). This nuclear fuel supply chain partnership requires a close planning of the fuel supply chain that includes detailed logistics arrangements on how the uranium will be shipped through multiple jurisdictions and the institutional planning of regulatory clearances and safety provisions. Such supplies are essential to the achievement of long-term climate objectives of India and the diversification of its non-fossil fuel energy.

Turkmenistan, conversely, has got a huge potential in terms of natural gas. The Turkmenistan-Afghanistan-Pakistan-India (TAPI) pipeline project is a symbol of pipeline diplomacy, a sub-category of energy diplomacy, aimed at establishing cross-border pipeline corridors of energy delivery, and building a geopolitical presence in the process. Despite delays and instability in Afghanistan, TAPI is taken as the key to the Indian aspirations to participate in long-term, overland trade in energy that does not rely on risky maritime routes (Huda and Ali, 2017; Pradhan, 2020). The TAPI project is a significant part of the Indian regional infrastructure development, which demands sophisticated financial analysis and estimates, risk analysis, and political assurances to guarantee feasibility and stability of the intended transport route.

2.6 India Policy on Outreach using the policy of Connect Central Asia

The participation of India in Central Asia reached the strategic stage as the formal declaration of the policy, known as the Connect Central Asia Policy (CCAP) in 2012 was declared. This program was a specific shift in Indian foreign policy as it no longer focused on bilateral relations but a multidimensional system. The political, economic, cultural, and strategic nature of the policy was a reflection of a realization that Central Asia was becoming more and more important in global energy geopolitics and regional stability (Siddiky, 2021; Ersi, 2024).

The connect Central Asia Policy was mainly focused on enhancing the institutional and strategic presence of India in the post-Soviet republics of Kazakhstan, Kyrgyzstan, Uzbekistan, Turkmenistan and Tajikistan that constitute the Central Asian Republics (CARs). These oil-abundant countries also have reserves of natural gas, uranium, and hydroelectric power and lie in a strategically important geopolitical route between Asia and Europe. They are of strategic importance to India not just in energy diversification but also in limiting

over-dependence on unstable West Asia which is politically unstable. India tried to achieve its strategic interests through energy alliances, establish strong trade and transit routes, and civilizational interconnections through CCAP.

Civil nuclear diplomacy is one of the pillars of the policy that has proven to be one of the most useful instruments of strategic interaction. Kazakhstan In 2011, India signed a civil nuclear accord with Kazakhstan that permitted it to acquire 5,000 metric tonnes of uranium to be used in its local nuclear power plants. This agreement strengthened Kazakhstan as a reliable source of uranium, thus boosting nuclear fuel security in India during the post-NSG waiver period (Kaulgud, 2022; Rao, 2018). Here, civil nuclear diplomacy describes the larger initiative by India to make technological collaboration a means of strategic independence as well as of achieving a planned, long-term supply chain. The second pillar of the CCAP has been based on formation of Joint Working Groups (JWGs). The inter-ministerial planning, the results of which are these institutional mechanisms, oriented at energy cooperation, counterterrorism, trade, and education, allow maintaining a continuation of dialogue on a level below the summit-level diplomacy. JWGs offer an opportunity to engage in issue-focused negotiations and establish partnerships based on practical collaboration and confidence-building strategies long-term (Bhattacharya, 2021; Kothari, 2020).

It has also been effective usability of soft power diplomacy in India, which can be defined as the capability to shape the global result using the means of cultural and non-coercive influence. Such offerings as the suggested Central Asian University, ICCR scholarships, the Days of Indian Culture in local capitals, and joint archaeological excavations highlight the Indian cultural outreach. These attempts aim to present a non-threatening image of the region, as well as to offset the aggressive soft power projection of competitors such as China and Turkey in the region (Pradhan, 2020).

Another important element of Indian concern on Central Asia is geostrategic connectivity. The geography creates a barrier to the reach of India to the region, particularly the lack of shared borders and Pakistan being hostile. Owing to this, India has increasingly resorted to the use of alternative transit corridors, which is a major aspect of its contingency planning, such as the Chabahar Port in Iran and the International NorthSouth Transport Corridor (INSTC). The infrastructure links belong to the bigger Indian Eurasian policy, as it allows it to evade chokepoints and create its presence in regional trade and energy distributions (Kalyuzhnova & Holzhacker, 2021). The idealistic ideas of the CCAP implementation have been quite hampered in their reality. The most significant of them is the so-called bureaucratic inertia, the institutional unwillingness to innovations or timely performance due to the inflexibility of procedures and the inability of agencies to synchronize with each other. This is a failure of institutional planning and actions on the ground. According to the analysts, an current majority of agreements signed under CCAP are under-implemented due to lack of either; a powerful follow up mechanism, political will or a sector of the private sector. Further, the concerns about logistical issues including lack of reliability of the transit corridors, poor financial instruments have compromised the full realization of Indian dreams. Herein lies a severe lack of logistical planning, risk-modeling, and development of relevant financial instruments (e.g., specific development funds or SPVs). Hence, the policy of the Connection Central Asia is quite symbolic and diplomatically significant yet its efficiency is doubtful. It is an increasingly widening disconnect between strategic intent and action at operational scale and that is why a policy architecture is necessary, and the infrastructural readiness and policy integrity of such infrastructure is enhanced. It would require an extensive audit of the national Indian energy infrastructure, the logistics of the trade, and the institutional mechanism that would allow the easy inclusion in the Central Asian energy corridors. The brightening of the Indian diplomatic activity must be accompanied with brightening of the study of the inner ability of the Indian country to assimilate, control and manage the inflow of energy in Central Asia as one of the main steps on transforming the geopolitical dreams into the realistic and sustainable realizations.

2.7 Logistical and Geopolitical Constraints

The whole logistical and geopolitical dilemmas, which plague India in trying to wield powerful energy relations with Central Asia are structurally constrained. Compared to the other possible regional power brokers such as China or Russia, India is not neighbors to any of the five Central Asian Republics, as both physical access and strategic connectivity is challenging. Such geographical remoteness has meant that India has had to use the third party transit networks in the overland, which is the Iran-Afghanistan-Pakistan axis, a route that is growing weaker with the alteration of the political situation in Afghanistan. Not only has the re-emergence of the Taliban led to the cause of instability in the region, but also nightmares of long-term logistics planning, and in that respect, India can hardly plan long-term transactions in terms of energy exchange or infrastructure with the assistance of this corridor (Rao & Pachauri, 2017; Kothari, 2020). The instability is a high-risk signal in the regional development plans of India and this will need an

immense risk-modeling and alternative, less risky supply chains. India has rushed to the Chabahar Port in Iran in order to balance these limitations. Chabahar, the Pakistani rival to the Gwadar Port, is included in the Indian fantasy to connect to Central Asia without necessarily passing through an unfriendly nation.. However, not much has been done. The Chabahar project has been dented by infrastructure delays, the twists and turns in relation between the United States and Iran, as well as the uncertainties surrounding international sanctions regimes. Consequently, what promised to be a game changer, inasmuch as regional interconnectedness is concerned, is yet to live up to its expectations of integrating energy (Singh & Kaur, 2014). **The failure here is twofold: a deficiency in transnational infrastructure planning and a lack of robust institutional mechanisms to shield the project from geopolitical regulatory risks.** To make the matter worse, there is the sluggish operationalization of the International North-South Transport Corridor (INSTC), a multimodal trade route, which is expected to link India to Central Asia, Russia, and Europe via Iran. The corridor, whilst theoretically feasible and diplomatically supported, has failed to live up to its potential because of the absence of high-level coordination and bureaucratic lethargy in the administrative apparatus of India. **The INSTC's poor performance is a direct result of inadequate execution planning, specifically the lack of a formal Project Management Unit (PMU) with quantified targets for multimodal logistics optimization (e.g., standardized customs procedures and unified freight rates).** The INSTC is more of a dream than a reality without the cohesive inter-ministerial alignment and sufficient investment in multimodal logistics (Kaulgud, 2022).

The situation is equally complicated with transnational pipeline diplomacy. The Turkmenistan-Afghanistan-Pakistan-India (TAPI) pipeline, although consistently supported at multilateral forums, has not recorded significant implementation. The chronic instability in Afghanistan, the continuing enmity with Pakistan, and the absence of financial guarantees have made the project a geopolitical captive. Although TAPI has quite a potential and could potentially meet the gas needs of India, it is stuck in the loop of late deadlines and a lack of risk-management solutions (Pradhan, 2020). It is a high-risk infrastructure development, with inadequate planning of mitigating political risk in the early planning phase, and binding financial commitments of transit countries. Domestically, political aspects of law and regulation are also a hindrance to India entering long-term strategic agreements in the energy sector. The Civil Liability for Nuclear Damage Act of 2010, which diverges from international norms by assigning liability to suppliers rather than operators, has deterred foreign investments, especially in civil nuclear agreements. Kazakhstan, one of the most resource-rich and geopolitically aligned partners, has expressed interest in collaboration, but the liability regime remains a significant barrier. **This liability regime is a self-imposed constraint on India's energy development plan, requiring a prioritized regulatory planning reform to align with global standards and enable secured, long-term nuclear fuel contracts.** Moreover, India's state-dominated energy sector, characterized by limited flexibility and overlapping jurisdictions, weakens its institutional agility in responding to fast-evolving regional opportunities (Kushwaha & Verma, 2021). Even India's energy diplomacy, despite its rhetorical emphasis on regional cooperation, suffers from an asymmetry of capabilities when compared to China's Belt and Road Initiative. India's fragmented infrastructure outreach, modest financial commitments, and regulatory complexities have resulted in a less persuasive diplomatic pitch. **This strategic asymmetry stems from a deficiency in integrated national planning and the absence of a dedicated development finance institution capable of matching the scale of rival investment plans.** This strategic asymmetry erodes India's negotiating power and reduces the effectiveness of its Central Asia outreach (Kaulgud, 2022). In totality, these logistical and geopolitical constraints have significantly moderated the pace and depth of India's integration into Central Asia's energy networks. Although policies and dialogues have been initiated with strong intent, their translation into actionable, durable frameworks has been inconsistent. Recognizing these systemic limitations, India has focused on strengthening its bilateral relationship with Kazakhstan, the region's most stable and energy-abundant partner, as a potential fulcrum to recalibrate its regional energy strategy (Ji & Sotnyk, 2023). **This recalibration must center on a highly planned, project-specific approach that prioritizes achievable logistics and immediate regulatory harmonization.**

2.8 Competing Powers in the Region: China, Russia, USA

India's ambition to deepen its energy and strategic ties with Central Asia must be viewed within a wider geopolitical theatre dominated by China, Russia, and, to a lesser extent, the United States and the European Union. Each of these powers has entrenched interests and distinct instruments of influence, which pose structural challenges to India's aspirations in the region. While India seeks to establish a secure and diversified energy supply chain, it finds itself contending with powerhouses

that already possess well-established institutional mechanisms, infrastructural footprints, and geopolitical leverage in the region.

China's engagement with Central Asia has grown exponentially through its flagship Belt and Road Initiative (BRI), which has laid down extensive economic corridors, oil and gas pipelines, fiber-optic networks, rail links, and transport routes that crisscross the region. **These massive projects are not merely transactional investments but represent a coordinated, long-term state-led infrastructural planning and political integration effort.** Through entities like the Asian Infrastructure Investment Bank (AIIB) and the Silk Road Fund, as well as direct bilateral arrangements, China has solidified its presence in all five Central Asian states (Ersin, 2024). Its strategic acquisition of uranium from Kazakhstan, the largest global producer of the mineral, has been central to its energy diplomacy, allowing Beijing not only to safeguard its domestic energy security but also to shape regional supply dynamics in its favor (Kurian, n.d.). China's long-term energy contracts and co-investment in extraction and refinement facilities **demonstrate a highly effective supply chain planning model that integrates resource acquisition with industrial development.** Russia, for its part, maintains a strong residual influence anchored in historical, cultural, and institutional continuities from the Soviet period. Through platforms like the Collective Security Treaty Organization (CSTO), the Eurasian Economic Union (EAEU), and the Commonwealth of Independent States (CIS), Moscow ensures that Central Asia remains within its strategic orbit. Russia's use of shared language (Russian as a lingua franca), elite education networks, dual citizenship, and interlinked economic structures has created a deep-rooted scaffolding of influence that India has yet to replicate (Rao, 2018). Even though India and Russia share warm bilateral ties, including in nuclear cooperation, space, and defense, Russia's institutional entrenchment offers it a far superior regional hold. **This historical advantage means Russia's regional strategy benefits from pre-existing institutional planning frameworks and infrastructural lock-in, requiring minimal new development planning compared to India.** The stationing of troops and military bases, preferential trade arrangements, and infrastructural dependency reinforce Russia's standing.

The United States and European Union adopt a more normative and values-driven approach to regional engagement. Their intermittent yet targeted diplomatic and economic engagements emphasize democratic governance, human rights, environmental standards, and institutional reforms. While their physical presence through infrastructure or energy corridors is minimal compared to China or Russia, their strategic influence lies in offering an ideological and developmental counterweight, often appealing to Central Asian regimes seeking to diversify external partnerships (Kushwaha & Verma, 2021). **Their planning model focuses on regulatory development and capacity building rather than large-scale infrastructural project implementation.** Nonetheless, their engagement remains sporadic and lacks the operational continuity and geographic proximity that characterize the regional strategies of Beijing and Moscow. US-backed projects often depend on broader geopolitical considerations and face institutional pushback from competing actors in the region. In contrast, India's strategic imprint remains relatively modest. Despite initiatives such as the Connect Central Asia Policy (CCAP), high-level summits, educational and cultural diplomacy, and capacity-building programs, India's comparative economic footprint is underwhelming (Muratbekova & Khitakhunov, 2024). It has been constrained by several factors: the absence of seamless connectivity to the region due to geographic discontinuity, **limited institutional capacity for project planning and implementation, regulatory inertia at home, and the lack of a unified development finance strategy.** It has also been constrained by an overreliance on multilateral platforms such as the Shanghai Cooperation Organization (SCO), where its leverage is diluted by the dominant positions of China and Russia (Dabhade, 2024). India's policy architecture has often been reactive rather than anticipatory, **representing a systemic failure in proactive strategic planning and institutional design necessary for competitive regional development.**

2.9 Nuclear Energy Strategy and Kazakhstan's Role

In India, there has been growing acknowledgement in energy policy on the significant role of nuclear power in energy diversification, low carbon emissions, and as a means to bolster national security (May 1996). As climate goals are ambitious under the Paris Agreement and pressure to decarbonize grows, nuclear energy is a non-intermittent, large-scale, low-carbon energy source that can provide base-load power demands. **Therefore, the expansion of the nuclear program is a core element of India's long-term energy planning and development strategy.** Nevertheless, although India has the technical skills and a developed nuclear system, the nuclear energy program has been traditionally confined by the scarcity of domestic uranium deposits and the political inhibition in the international market. **This constraint requires a deliberate strategic**

planning response focused on international resource acquisition.

Since liberalization in the 1990s, India has progressively attempted to globalize its nuclear strategy, especially following the Indo-US Civil Nuclear Agreement in 2008. This created a structural opportunity to secure uranium supplies from states that were previously off-limits, including Kazakhstan, a state that has rapidly emerged as one of the top global producers of uranium. The 2011 bilateral agreement between India and Kazakhstan for the supply of 5,000 metric tonnes of natural uranium marked a pivotal moment in this trajectory, elevating Kazakhstan to the status of a strategic energy partner (Pradhan, 2022). **This agreement is a direct outcome of policy planning aimed at securing a planned and stable fuel supply chain for India's nuclear power development targets.**

Kazakhstan's reliability stems not only from its resource endowments but also from its geopolitical posture. Unlike West Asian suppliers whose reliability is complicated by regional instability and shifting alliances, Kazakhstan offers a neutral, stable, and predictable partnership. The country's consistent adherence to International Atomic Energy Agency (IAEA) protocols and its proactive participation in global non-proliferation efforts underscore its value as a long-term partner for India's peaceful nuclear program (Sarkar, 2022; Sajjanhar, 2013). **The selection of Kazakhstan is a strategic planning decision based on a comprehensive risk assessment of supply stability and regulatory compliance.**

Through the diversification of partnerships and investment in cooperation in R&D, India minimizes its vulnerability to shocks in the global market and asserts its position in the global nuclear diplomacy. Moreover, the new relationships between Kazakhstan and Russia, particularly in the uranium enrichment and downstream fuel cycle services, provide India with a warning and a potential point of closer interaction (Siddi & Silvan, 2023). The resources are not the only limit of the strategic logic of the nuclear cooperation between India and Kazakhstan. Rather, the required component of a coordinated development plan is cooperation. It is part of a collective change in Indian foreign policy to develop energy relations capable of assisting it in achieving its climate targets and its great-power targets. This would make India-Kazakh nuclear diplomacy a platform in Indian Central Asian outreach - a nexus of technology, geopolitics, and sustainable development (Pardesi & Ganguly, 2020). The relation is also part of a larger strategic repositioning where there is not the answer of Central Asia as merely an alternate energy provider, but as an entire ally in the Indian energy future. All of these aspects (technological integration, joint R&D, and harmonization of the regulations) must be planned regularly to ensure that the development goals of shared nuclear energy are long-term viable in this partnership (Paul, 2024).

2.10 Repositioning Central Asia in India's Energy Doctrine

The energy diplomacy recalibration of the 21st century draws attention to the fact that India needs to increase its energy security and achieve more geopolitical autonomy (Rentschler and Bazilian, 2017). Central Asia, traditionally considered as a periphery in the Indian energy calculations, is now re-conceptualised as an important strategic energy partner in the Indian energy doctrine. A critical analysis by India of systemic weaknesses in its classical supply chains (especially those dependent on maritime chokepoints or politically unstable geographies) has been one of the factors that have contributed to this reorientation (Inchauste & Victor, 2017). Not only can this region be diversified with the abundance of hydrocarbons, uranium, and hydropower, but it can also be another instance of the strength of energy. Instead of using Central Asia as an exit strategy, India is making Central Asia central to a sound and multipolar energy development strategy. This sort of transformation favours long-term and diversified relationships at the expense of episodic and transactional relationships. The unreliability of the West Asian oil stream, as well as the vulnerability of the sea supply lines, has provided a reason behind the growing interest in increasingly moderate suppliers, whose pathways are linked by land. The Central Asian republics, such as Kazakhstan, Uzbekistan, and Turkmenistan, are increasingly more attractive, and their emerging post-Soviet energy infrastructure and propensity toward multilateral cooperation (Movkebaeva & Sadvakassova, 2021) are becoming an even more attractive option.

Of particular importance is the fact that India is relocating its relationships based on bilateral interaction to a multilevel institutionalized energy system. The new planning model, which is suggested to replace the earlier planning model, is the India--Central Asia Energy Coordination Group that will facilitate collaboration in upstream exploration, harmonization of nuclear safety standards, combined investment, and joint research and development of clean technologies. Not only does economic cooperation occur via these platforms, but the mutual trust is institutionalized, volatility is reduced, and regional stability is promoted.

The consolidation of multilateral diplomacy of India is also consolidated in the region. India is embedding its energy diplomacy into regional regimes, e.g., full membership of the Shanghai Cooperation Organisation (SCO+) and observer

member of the Eurasian Economic Union (EAEU). At the same time, India, in its turn, has been following the path of the International Atomic Energy Agency (IAEA), which contributes to the image of a responsible nuclear player that is critically needed, considering the context of the uranium reserves in Kazakhstan and already established bilateral relations (Hans, 2023). The Chinese Belt and Road Initiative (BRI) and the Russian regionalization of the old networks, as the CSTO, are the backdrop against which one can observe an Indian idiomatic approach to energy engagement. India is planning to employ soft power diplomacy through providing educational connectivity, capacity building, as well as the establishment of institutions as an alternative to enforcing capital-intensive infrastructural dependencies as a way of creating a framework of long-term cooperative development. It is, however, a less aggressive approach compared to the rapid infrastructural deliverables, but far more sustainable, which is what the Central Asian nations desire to observe regarding the balancing partnership (Sovacool, 2017).

Here, symbolism and strategic sense meet in this current doctrine of India. Such interest in Central Asia describes an enlarged shift in Indian foreign policy imaginations- active regionalism. New Delhi strengthens a conception of flexibility, resiliency, and positive multilateralism by accommodating Central Asia as an energy politics and economic connectivity negotiating partner. Such re-positioning has a purpose beyond the geographic pragmatism- a paradigmatic re-working of the energy doctrine of India. Not only a shift of supplier reliance to diversified sourcing, however, a shift of transactional collaboration to visionary collaboration, based on shared development aims. It is associated with a high-tech, futuristic strategy, which is congruent with the global interdependence and systemic risk, the urgent need for energy transitions that should be sustainable. Central Asia will then be a pilot project to determine whether India can translate its energy diplomacy into measurable, integrated development policies to effect strategic independence and world presence.

References

1. Agarwal, S., Ghosh, P., & Zheng, H. (2024). Consumption response to a natural disaster: evidence of price and income shocks from the Chennai flood. Energy Economics, 131, 107323.
2. Aggarwal, A. Special Economic Zones in South Asia.
3. Barbar, M., Mallapragada, D. S., & Stoner, R. J. (2023). Impact of demand growth on decarbonizing India's electricity sector and the role of energy storage. Energy and Climate Change, 4, 100098.
4. Barbar, M., Mallapragada, D. S., Alsup, M., & Stoner, R. (2021). Scenarios of future Indian electricity demand accounting for space cooling and electric vehicle adoption. Scientific Data, 8(1), 178.
5. Bardhan, R., Debnath, R., & Jana, A. (2019). Evolution of sustainable energy policies in India since 1947: A review. Wiley interdisciplinary reviews: Energy and environment, 8(5), e340.
6. Bhattacharya, D. (2021). India-Central Asia Relations. Indian Foreign Affairs Journal, 16(4), 341-350.
7. Bhattacharya, D. (2022). India-Central Asia Summit: Shaping geopolitics in the extended neighbourhood. Observer Research Foundation.
8. Chatterjee, E. (2017). The limits of liberalization: The power sector. In the Political Economy of Contemporary India. Cambridge University Press.
9. Chatterjee, E. (2024). Late Acceleration: The Indian Emergency and the Early 1970s Energy Crisis. The American Historical Review, 129(2), 429-466.
10. Dabhade, M. S. (2024). India's New Diplomacy in Central Asia: Analysing the First India-Central Asia Summit. In India and Inner Asia (pp. 197-209). Routledge India.
11. Ding, Y., Mallapragada, D., & Stoner, R. J. (2025). The role of coal plant retrofitting strategies in developing India's net-zero power system: A data-driven sub-national analysis. Energy for Sustainable Development, 86, 101687.
12. Dubash, N. K. (Ed.). (2019). India in a warming world: Integrating climate change and development. Oxford University Press.
13. Ersin, B. Y. (2024). India's "Connect Central Asia Policy" within the Context of the International North-South Transport Corridor. In India's Economic Corridor Initiatives (pp. 136-150). Routledge.
14. Ghosh, M. (2023). Growth and Development under Alternative Policy Regimes in India: A Political Economy Perspective. Journal of Asian and African Studies, 58(7), 1134-1155.
15. Goyal, N. (2020). Promoting policy innovation for sustainability: Leaders, laggards and learners in the Indian electricity transition (Doctoral dissertation, National University of Singapore (Singapore)).
16. Gupta, V., Sarkar, A., Deb, C., & Jana, A. (2025). Evaluating energy inefficiency in energy-poor households in India: A frontier analysis approach. arXiv preprint arXiv:2504.17056.
17. Hans, V. (2023). Multilateralism and India: Navigating Global Challenges Through Collaborative Diplomacy. Multilateralism and India: Navigating Global Challenges Through Collaborative Diplomacy (December 2, 2023).

18. Huda, M. S., & Ali, S. H. (2017). Energy diplomacy in South Asia: Beyond the security paradigm in accessing the TAPI pipeline project. Energy research & social science, 34, 202-213.
19. Hunt, K. M., & Bloomfield, H. C. (2025). Building and explaining data-driven energy demand models for Indian states.
20. Inchauste, G., & Victor, D. G. (2017). The political economy of energy subsidy reform. World Bank Publications.
21. Irfan, M., & Ojha, R. K. (2023). Foreign direct investment inflows and energy diversification in the emerging seven economies: evidence from a panel data analysis. International Journal of Emerging Markets, 18(12), 5545-5564.
22. Ji, Z., & Sotnyk, I. M. (2023). Economic analysis of the energy efficiency of China's and India's national economies.
23. Kalyuzhnova, Y., & Holzhacker, H. (2021). Enhancing connectivity and trade between Central Asia regional economic cooperation countries and the world: Benefits, risks, and policy implications (No. 1271). ADBI Working Paper Series.
24. Kathuria, V., & Natarajan, R. R. (2022). What Role Has Structural Change Played in Growth Accelerations for the Indian States? An Analysis for Pre-and Post-liberalization Periods. South Asia Economic Journal, 23(1), 61-85.
25. Kaulgud, M. V. (2022). India-Central Asia Energy Relations: Prospects and Barriers. Social and Political Research Foundation (PRF. IN).
26. Khan, K. (2025). How do supply chain and geopolitical risks threaten energy security? A time and frequency analysis. Energy, 134501.
27. Kothari, R. K. (2020). India's Strategic Interests In Central Asia. World Affairs: The Journal of International Issues, 24(1), 100-117.'
28. Kumar, M. (2025). Reclaiming the Shakya Lineage: Buddhist Youth and Memory at Sankisa in Uttar Pradesh (Doctoral dissertation, UNIVERSITY OF BRITISH COLUMBIA (Okanagan).
29. Kurian, A. L. INDIA'S ENERGY DIPLOMACY IN CENTRAL ASIA: CHALLENGES AND OPPORTUNITIES.
30. Kushwaha, R. P., & Verma, S. S. (2021). India's Energy Diplomacy Towards Central Asia. Shodh Sarita, 8(29), 243-248.
31. Laldjebaev, M., Isaev, R., & Saukhimov, A. (2021). Renewable energy in Central Asia: An overview of potentials, deployment, outlook, and barriers. Energy Reports, 7, 3125-3136.
32. Malhotra, A., Mathur, A., Diddi, S., & Sagar, A. D. (2022). Building institutional capacity for addressing climate and sustainable development goals: Achieving energy efficiency in India. Climate Policy, 22(5), 652-670.
33. Malhotra, A., Schmidt, T. S., Haelg, L., & Waissbein, O. (2017). Scaling up finance for off-grid renewable energy: The role of aggregation and spatial diversification in derisking investments in mini-grids for rural electrification in India. Energy Policy, 108, 657-672.
34. May, C. (1996). Strange fruit: Susan Strange's theory of structural power in the international political economy. Global Society: Journal of Interdisciplinary International Relations, 10(2), 167-189.
35. Mehta, K., Ehrenwirth, M., Trinkl, C., Zörner, W., & Greenough, R. (2021). The energy situation in Central Asia: A comprehensive energy review focusing on rural areas. Energies, 14(10), 2805.
36. Movkebaeva, G. A., & Sadvakassova, A. M. (2021). Cooperation between India and Central Asia and its importance for the region. Bulletin of Karaganda University Series History. Philosophy, 102 (2), 98-106.
37. Muratbekova, A. M., & Khitakhunov, A. A. (2024). INDIA'S FOREIGN POLICY IN KAZAKHSTAN: ANALYSIS OF COOPERATION POTENTIAL. International Relations & International Law Journal/Seriâ Meždunarodnye Otnošeniâ & Meždunarodnoe Pravo, 105(1).
38. Pandey, J. G., & Kumar, A. (2025). Navigating India's energy transition: A systematic literature review of risks in the coal phase-down process. Renewable and Sustainable Energy Reviews, 210, 115260.
39. Pardesi, M. S., & Ganguly, S. (2020). India and energy security: A foreign policy priority. In Indian foreign policy in a unipolar world (pp. 99-127). Routledge India.
40. Paul, T. V. (2024). The unfinished quest: India's search for major power status from Nehru to Modi. Oxford University Press.
41. Pradhan, R. (2020). Energy geopolitics and pipeline diplomacy in Central Asia: India's interests and policy options. Jadavpur Journal of International Relations, 24(2), 216-246.
42. Pradhan, R. (2020). Geopolitics of Energy in Central Asia: India's Position and Policy. Routledge India.
43. Pradhan, R. (2022). India-Kazakhstan energy relations: Looking back and looking ahead. Journal of Eurasian Studies, 13(2), 103-118.
44. Raizada, S., Sharma, D., Laan, T., & Jain, S. (2024). Mapping India's Energy Policy 2023.
45. Raj, K., & Sharma, D. (2024). Effects of energy price shock on the macroeconomic indicators of India: a new measure. International Journal of Energy Sector Management, 18(6), 1787-1812.
46. Rao, K. P. (2018). A study on India and Central Asia relations through the lens of energy

politics. ZENITH International Journal of Multidisciplinary Research, 8(2), 75-85.
47. Rao, N. D., & Pachauri, S. (2017). Energy access and living standards: some observations on recent trends. Environmental Research Letters, 12(2), 025011.
48. Rentschler, J., & Bazilian, M. (2017). Reforming fossil fuel subsidies: drivers, barriers, and the state of progress. Climate Policy, 17(7), 891-914.
49. Sajjanhar, A. (2013). India-Kazakhstan relations: Challenges and opportunities. Indian Embassy in Kazakhstan.
50. Sarkar, P. (2022). India's strategy of energy security in Central Asia: a case study of Kazakhstan (1991-2020).
51. Siddi, M., & Silvan, K. (2023). Russia and Kazakhstan in the global nuclear sector: From uranium mining to energy diplomacy.
52. Siddiky, C. I. A. (2021). The geopolitics of energy in South Asia: Energy security of Bangladesh. Routledge.
53. Singh, K., Meena, R. S., Kumar, S., Dhyani, S., Sheoran, S., Singh, H. M., ... & Byun, C. (2023). India's renewable energy research and policies to phase down coal: Success after the Paris agreement and possibilities post-Glasgow Climate Pact. Biomass and Bioenergy, 177, 106944.
54. Singh, S., & Kaur, A. (2014). Connect Central Asia Policy Factor in India's soft power initiatives in cars: problems and prospects. International Journal of Advanced Research in Management and Social Sciences, 3(12), 94-114.
55. Sobha, P. (2022, January). Decarbonizing the Indian Electricity Grid. In International Conference on Electrical and Electronics Engineering (pp. 312-322). Singapore: Springer Nature Singapore.
56. Sovacool, B. K. (2017). Reviewing, reforming, and rethinking global energy subsidies: towards a political economy research agenda. Ecological Economics, 135, 150-163.
57. Srivastav, A. (2020). Energy security and sustainability: an overview. Energy Dynamics and Climate Mitigation: An Indian Perspective, 1-31.
58. Tongia, R. (2022). Balancing India's 2030 electricity grid needs management of time granularity and uncertainty: insights from a parametric model. Transactions of the Indian National Academy of Engineering, 7(4), 1127-1150.
59. Zohuri, B. (2023). Evolving National Security: A Roadmap from Present to Future in Renewable and Nonrenewable Energy Policies (A Technical Review). Journal of Energy and Power Engineering, 17, 102-108.

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Nuclear Energy and Sustainable Development: Social, Policy, and Spatial Dimensions of Climate Mitigation and Energy Security in India

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Abstract

Climate change and energy security are two of the most critical and interconnected challenges facing the world today. Heavy reliance on fossil fuels such as coal, oil, and natural gas, while historically driving industrial growth, is the main driver of greenhouse gas emissions, global warming, and environmental degradation. Moreover, the global energy system remains highly vulnerable to geopolitical tensions, price shocks, and supply chain disruptions, while extreme weather events directly impact power generation and grid stability. Addressing these challenges requires reliable, affordable, and sustainable energy solutions that support both economic stability and long-term development. Achieving these goals demands a shift toward cleaner and more resilient energy systems. India, committed to reaching net-zero emissions by 2070, must diversify its energy mix beyond fossil fuels. Nuclear energy offers a promising solution: it provides stable, continuous, low-carbon baseload power while shaping regional development patterns and supporting socio-economic resilience. However, successful deployment depends not only on technological progress but also on public acceptance, participatory governance, and equitable spatial planning to ensure benefits reach all regions. Strategic investments in grid modernization, energy storage, and community support are essential to manage the transition and mitigate its social impacts. Embedding nuclear expansion within broader development and planning frameworks can simultaneously advance climate goals, strengthen energy security, and promote inclusive growth. Coordinated global efforts and collaborative policy approaches will be crucial for achieving a stable, sustainable, and socially just energy future.

Keywords: Energy Security, Small Modular Reactors, Climate Change, Nuclear Energy, and Nuclear Safety Education.

Introduction

Climate change has been so urgent that the world has been forced to shift towards clean and renewable sources of energy. Meanwhile, the energy security remains a significant concern, particularly among the developing economies such as India who have their fair share of imports when it comes to fossil fuel. An integrated approach to energy should be established to balance such objectives. One such energy is nuclear energy as it has almost no carbon footprint and can serve as base load power. With nuclear power, a base load electricity can be generated in large volumes and also it is dependable and is a low-carbon source of energy. India has committed to reducing its intensity of emissions by 45 percent by 2030 and achieve net-zero emission by 2070. However, over 72 percent of electricity in India is still produced by coal. The country is exposed to geopolitical and market risks because the country relies on imported oil and gas. Inclusion of nuclear energy in the US energy portfolio can assist in decreasing these threats as well as assisting in achieving climate objectives. Nevertheless, energy transitions are not technological solutions, they are technologically determined, technologically driven and socially structured, technologically governed and technologically planned. The introduction of nuclear energy has effects on the development of the regions, growth and urbanization planning as well as offers the employment opportunities and motivates the local economies. Such initiatives are also dependent on the public perception and acceptance of nuclear power which is important and founded on safety awareness, institutional trust and transparent

decision-making. Solar development of nuclear energy must, therefore, be viewed as not only a technical and economical solution, but also a policy tool with more than one dimension, delimiting social performance and patterns of spatial development. The power generation capacity of the nuclear power plants in India reaches about 7.5 GW of energy capacity, which is approximately 3 percent of the national energy. This ought to be 22 GW by 2031 and 100 GW by 2047, which is the aim of the government in terms of its long-term clean energy goals. This paper discusses the Indian climate and energy policies in regard to nuclear energy. It discusses both the positive and negative side of the rise of nuclear energy and the policies that must be taken to see the same through. It rests on the extent to which nuclear energy can provide low-carbon reliable and safe energy as well as how it can contribute to inclusive social development, equitable and integrated regional growth and spatial planning strategies that will help India concentrate on its overall sustainable developments.

Methodology

A qualitative analysis approach was used in this study to investigate the nuclear energy program, its trajectory, why nuclear energy is a significant component in the global clean energy mix, the issues that arise when attempting to scale up nuclear energy, and what solutions to these issues can be found by relying on a diversity of strategies informed by diverse sources, such as books, journals, news articles, and official websites.

that are pertinent to the subject. In addition to investigating the technical and policy literature, this review has employed the socio-spatial analytical lens to capture the broader social sciences and the elements of planning of nuclear energy deployment. The argument considers the functions of the system of governance, the strength of institutions, social acceptance and inclusion of stakeholders in the utility of nuclear measures. It also takes into consideration spatial concerns that encompass geographic distribution of nuclear infrastructure, implication of such regional development, and land-use planning concerns, and inequalities in access to energy resources. It will assist the research not only in carrying out of a survey of the technological trends, but also in putting the nuclear energy into the wider perspective of the social implications, spatial development strategy and the sustainable planning objectives.

Discussions

Nuclear energy has re-entered the picture as a major constituent of the global clean energy nexus as the world struggles against the climate change and the need to shift to low-carbon energy sources. It provides uniformity of power supply, lower green house gases and abundant energy over a small space. In spite of these benefits, scaling up of nuclear energy has several technical, economic, political and social problems. These problems should be approached strategically so as to realize the optimal utility of nuclear power in the 21 st century. Mass production of nuclear power is an arduous but necessary process, which the world must go through to reach its net-zero and energy-security goals (Bhaduri, A and Deshpande, 2022). However, it does not rely solely on technological advancement to achieve these goals, yet social process, institutional structure, and spatial planning also have to be considered. The final factor that determines the rate of nuclear use is social acceptance and trust of the people. These are informed by open governance, effective communication on risk and participation of the decision processes. The spatial feature of the nuclear infrastructure planning is not negligible as well. It is pertinent to strengthen socio-economic advantages of nuclear energy, land-use policy, site selection and equity in the distribution of infrastructure in the regions and integration of nuclear facilities into the overall spatial development plans. Socially inclusive and spatially balanced solution will make nuclear power be not only contributing to solving the problem of emissions and achieving the energy security, but also to the development of the region, to employment rates, and to the equal access to the energy. Nuclear energy is a stable and low-carbon energy source, although its development is curtailed by its high cost, complex regulations, consumer distrust, waste disposal issues, and geo-political risks. We require political will and new sources of income, collaboration with other nations and above all new vision of nuclear power as safe, modern and necessary in the clean energy transition. Moreover, collaboration between government institutions, civil society, and local communities is vital to overcome resistance and ensure legitimacy. Policies must integrate social impact assessments and include affected populations in decision-making about plant locations, compensation frameworks, and safety protocols. Additionally, spatial planning tools — such as regional development plans, land-use zoning, and infrastructure mapping — should be embedded in nuclear policy formulation to align energy projects with long-term urbanization, industrial, and environmental objectives. The main point of the paper will be how emerging economies like India can build a nuclear energy program that is not only safe, long-lasting, and scalable, but also socially accepted, spatially equitable, and deeply integrated into national development and planning frameworks.

1. Change the liability rules to make it easier for foreigners to get involved in nuclear energy. In developing nations such as India, international cooperation, investment, and transfer of technology

is very crucial to expansion and modernisation of the nuclear energy infrastructure. Civil nuclear liability regime structure, conversely, is among the most significant factors that are preventing foreign investment to be attracted. It is highly desirable to reform the existing liability schemes to attract international vendors to visit, have access to advanced technologies, and grow nuclear capacity in accordance with climate and energy security aspects. Social and Spatial Policy Relevance. The design of liability is not just a legal-commercial question; it defines the trust of the population, controls risks, and the topography of nuclear investment. Well-defined and foreseeable regulations influence the location of projects, distribution of benefits and risks on the local level, and the ability of communities to receive plausible assurances of compensation, remediation and long-term they observe. These kinds of changes need to find a balance between making sure that victims of nuclear accidents get paid and making the legal system more predictable for private investment and cooperation between countries.

Understanding the Problem of Liability

Governance and Participation. Effective liability regimes integrate stakeholder participation in drafting rules, clear claims pathways for affected households and workers, and local ombuds to resolve disputes. Embedding these features improves institutional legitimacy, speeds post-incident recovery, and increases community willingness to host facilities. Civil nuclear liability is the legal duty to pay for damages caused by nuclear accidents, such as damage to the environment, health problems, and loss of property. Liability frameworks have traditionally put all the blame on the operator of a nuclear facility, protecting suppliers and manufacturers from claims after an accident. The Paris Convention (1960), the Vienna Convention (1963), and the Convention on Supplementary Compensation for Nuclear Damage (1997) all support this way of doing things (IAEA, 2021). The goal of these international agreements was to make things more uniform, reduce legal uncertainty, and make it easier for nuclear trade to happen across borders. However, some national laws, like India's Civil Liability for Nuclear Damage Act (CLND) of 2010, don't follow these rules. If the operator gets faulty equipment or services, Section 17(b) of the CLND Act gives them the "right of recourse" against suppliers. This clause has made foreign suppliers, especially those from the US, France, and Japan, nervous because it puts them at risk of unlimited third-party liability (Raj & Narain, 2020). Because of this, many multinational companies have been hesitant to work on nuclear projects in India, even though there are high-level civil nuclear agreements and strategic partnerships in place. Spatial Equity Implications. Predictable liability and insurance pooling encourage balanced regional siting instead of concentrating plants only in already-developed corridors. Reforms should include community benefit agreements (CBAs)—earmarked funds for local health services, emergency preparedness, infrastructure, and livelihood programs—to ensure host regions are net beneficiaries.

Implications for foreign participation: A liability regime that is hard to predict or too strict makes it less likely that foreign investors will put their money into the country or share their technology. Projects to build nuclear power plants cost a lot of money, are hard to understand, and take a long time to finish. Suppliers need to know that their responsibilities after an accident will be limited and handled through legally established operators and insurance systems. Liability standards that aren't consistent not only make business risky, but they also go against international best practices, making it harder to take part in global supply chains (World Nuclear Association (WNA), 2023a). Reforming liability systems is especially important for making it easier to use new nuclear technologies like Small Modular Reactors (SMRs) and Generation IV reactors, which are often made by groups of countries working together. These technologies may stay out of reach for many countries that could benefit from them the most if there isn't clear legal protection for suppliers.

Strategies for reform and best practices around the world

a). To deal with these issues, reforms should focus on making it clear what suppliers are responsible for, making sure they follow international rules, and making insurance pools bigger so that they can cover all possible damages. One possible solution is to change or reinterpret Section 17(b) of India's CLND Act so that it is in line with the CSC's provisions, which India has agreed to. This could be done by the parliament making things clearer, passing more laws, or making rules that limit the use of recourse rights to certain, proven cases of gross negligence or willful misconduct (Misra, 2019).

b). The growth of a complete nuclear insurance market, backed by both public and private companies, is another important part. A sovereign guarantee or international backstop mechanism can help insurers pool risks, which can give them the money they need to protect victims without scaring off suppliers (IAEA, 2021c).

c). It's important that any changes are made with clear public involvement and consultations with all stakeholders, including civil society, business, and legal experts. This makes sure that the regime stays credible and keeps its main job, which is to protect citizens' rights in the event of a nuclear accident.

d) **Community Compensation Protocols.** Standardise compensation schedules, medical surveillance, and environmental remediation timelines for host districts, with independent audits and annual public reporting.
e) **Local Capacity Building.** Allocate a fixed share of premiums/fees to train district-level emergency responders, public hospitals, and labs, strengthening medical and environmental monitoring capacity in host regions.

2. Speed up the deployment of Small Modular Reactors (SMRs)- SMRs are a new way of making nuclear energy that changes the game. Their modularity, ability to grow, and extra safety features make them a good way to meet the world's energy needs while cutting down on carbon emissions. People are becoming more interested in nuclear power again, especially Small Modular Reactors (SMRs), because of the global push to reduce carbon emissions. These reactors, which usually produce less than 300 MWe per unit, are a new way to make nuclear energy that costs less to set up and is safer (IAEA, 2021a). SMRs are nuclear fission reactors that are made in factories and then brought to the site to be put together. SMRs can be deployed in stages, unlike traditional large-scale reactors, and are better for small grids or places that are hard to reach (NEA, 2021). Some important features are:
Modularity: Factory-made parts make it possible to deploy systems that can grow.
Improved Safety: Passive safety systems make it less likely that you will need outside help or power.
Flexibility: can support electricity, district heating, desalination, and hydrogen production (Ingersoll et al., 2014).

Benefits of SMRs
Economic Efficiency: SMRs cost less to build and take less time to build. Their modular design lowers investment risks because it lets deployments happen in stages (World Nuclear Association, 2023).
Safety Improvements: Many SMRs use passive safety systems, integral reactor vessels, and low-pressure coolant systems to lower the chance of accidents (IAEA, 2021a).
Grid Compatibility: SMRs are great for generating power in a decentralized way, especially in countries with small or isolated grids (NEA, 2021).
Challenges confronted with SMRs: Even though they have a lot of potential, SMRs have a lot of problems to deal with:
Socio-Spatial Siting Criteria. SMR siting should prioritise regions with energy deficits, industrial demand centres, and resilient logistics, while evaluating land use, water access, population density, evacuation routing, and cultural heritage. This supports equitable regional development and reduces opposition linked to perceived risk concentration.

Regulatory issues: Nuclear power is back in the news because of the global push for decarbonization and energy security. Small Modular Reactors (SMRs) are one of the new technologies in this field that stand out because they could provide safe, flexible, and low-carbon energy solutions. Even though SMRs have a lot of potential, there are a lot of problems that need to be solved before they can be used widely. It is one of the greatest issues to have to navigate the rules and regulations. The main causes of these problems are mostly due to outdated licensing systems, complex designs never undertaken before and absence of global consensus. Combined, they make it extremely difficult to make SMRs economically viable and on-time deployed. The fact that the rules that we currently have do not apply to the new reactor designs is one of the greatest issues facing SMRs. The majority of regulations relating to nuclear power plants had been formulated half way through the 20 th century, when the light-water reactor was the most predominant of the reactor types. According to the conventional designs, these regulations have assumptions concerning the size of the plant, its safety, how it will hold back an accident, and how it will plan for an emergency. Conversely, SMRs incorporate small modular designs that have inbuilt safety features, inbuilt reactor vessels and may have alternative coolants or fuels. Due to this, existing regulations do not tend to consider the technical distinctions between SMRs, thus increasing the length of approval and obscuring the rules. As an illustration, despite the fact that SMRs might not require as many containment structures or off-site emergency zones as other structures, they would disfavor their economic and spatial advantages (Locatelli et al., 2017). The outdated nature of the rules is not the only issue, as many of the SMR designs are the first of their kind (FOAK) as well. Each design of a new reactor has to be subjected to a rigorous safety test, environmental assessment and consultation. These steps are necessary to keep the public's trust and protect the environment, but they also require a lot of paperwork, testing, and repeated reviews. Because of this, getting regulatory approval can take five to ten years and cost a lot of money, especially for companies that don't have the same resources as big utility companies. This longer timeline makes it less likely that private investors will put money into SMRs, raises the risks of development, and makes the business case for SMRs weaker, especially in countries where bureaucratic processes move slowly (Kessides, 2012). Additionally, these problems are made worse by the fact that nuclear regulations are not the same around the world. At the moment, each country has its own rules for getting a license, technical codes, and safety standards. This fragmentation makes it harder for developers who want to sell SMRs in more than one place. For instance, a reactor design that is legal in the

US may need a lot of changes or requalification to meet the rules in Europe or Asia. This not only raises prices, but it also makes it harder for SMRs to grow and be sold abroad. Because of this, groups like the International Atomic Energy Agency (IAEA) and the OECD Nuclear Energy Agency (NEA) have started working to get member states to work together more, but progress is slow and mostly up to the members themselves (IAEA, 2021). There is also a lot of uncertainty about how new uses of SMRs will be regulated, which adds to the problem. SMRs are meant to do a lot of different things, like provide power to remote grids, heat for factories, hydrogen production, and even floating or mobile platforms. This is different from traditional nuclear plants. These new uses make it hard to tell where traditional reactor oversight ends and where it begins, and they often fall into regulatory gray areas. In a lot of countries, there isn't a clear way to get a license for nuclear-powered district heating or hybrid energy systems. Without clear, flexible frameworks, projects take longer to finish and there are legal gray areas that make people less likely to come up with new ideas. Lastly, even when large reactors are utilized on SMRs whose passive safety characteristics are superior, emergency preparedness and security needs are frequently still pegged to large reactors. Most SMRs are designed to be shut down automatically (i.e. not by an operator or external power). This lowers the degree of risk and intensity of possible accidents. The existing regulations might however consider huge exclusion area, extensive emergency control and costly security system that may not just make SMRs non-portable, but also exorbitant. To maximize the use of the SMRs, it will be pertinent to revise such rules in order to illustrate their actual risk profile. Finally, regulatory issues are also a titanic issue as far as the use and development of Small Modular Reactors are concerned. The technology itself is a promising technology, but transition is a costly process that is time consuming due to the archaic regulations, lack of worldwide compatibility and uncertainty as to full use of the technology. In order to realize the radical potential of SMRs, regulatory agencies need to be risk-based, technology-holistic and internationally integrated. Participatory Licensing. Together with the risk-based control, the compulsory open consultations, the risk feature briefs in the local language, the citizen forums throughout the environmental approvals process, and the redress of complaints, which are legally binding. These actions add to the trust in the institution and minimize delays that are brought about by conflict. To get to the next stage of nuclear innovation, regulation processes should not only be streamlined but also made more efficient without reducing the level of safety and confidence of the citizens.

Market Uncertainty: Market uncertainty is a huge issue to SMRs in the market. The reasons behind this uncertainty are numerous, including the high development costs, the not well understood demand, the availability of cheaper alternatives, issues with financing access, lack of existing proven business models. All these make investors less assured, sluggish to roll out and the economic case of SMRs have become weaker in the present energy environment. One of the largest factors that put the market in doubt is the high cost of developing SMRs. The entire process of research, licensing and commercializing new designs is expensive and makes SMRs expensive and costlier than the regular large scale reactors albeit on a unit basis. The costs associated with SMR projects are usually first-of-a-kind (FOAK) due to design modification, time-lapse between approvals and a supply chain that is not yet completely established. Before they can even make a profit, developers and utilities have to spend hundreds of millions, and sometimes billions, of dollars. This financial risk keeps private investors and even governments from investing, especially when there is no guaranteed market demand or long-term power purchase agreements (Ingersoll et al., 2014). The fact that we don't know what the market will want in the future makes this even harder. SMRs could be used for many things, like off-grid energy, industrial heat, hydrogen production, and electrifying remote areas, but these markets are still mostly untested. Mining companies and island nations are two examples of potential customers who are risk-averse and don't want to commit to an expensive and relatively new nuclear technology. Also, many of the areas that could benefit the most from SMRs, like parts of Africa and Southeast Asia, have problems with regulatory capacity, grid infrastructure, and political stability, which makes it even harder to enter the market (Kuznetsov & Lokhov, 2011). The market is also more uncertain because of competition from other energy sources. The price of renewable energy technologies, especially solar and wind, has dropped a lot in the last few years. Renewables are becoming more flexible and affordable ways to decarbonize energy systems as battery storage, smart grids, and hydrogen technology improve. On the other hand, SMRs are still mostly theoretical or in the early stages of demonstration, and there is no proven cost curve to show how they work. This difference in cost makes it hard for SMRs to compete on price, especially in open electricity markets where price is a big factor in making decisions. If SMRs can't show that they are clearly valuable in terms of reliability, baseload supply, or hybrid integration, they might be passed over in favor of options that are faster to deploy and less risky. Problems with financing make the market even more uncertain. Commercial lenders don't like nuclear energy projects, including SMRs, because they need a lot of money up front and take a

long time to pay back. It is hard to make investment choices because there are no established financial models for SMRs, like build-own-operate or leasing agreements. Also, private sector actors are often not willing to put up money without strong support from the public sector, insurance frameworks, or policy incentives like carbon pricing or tax credits for clean energy. SMR projects have very bad financial prospects in countries where the government doesn't help much or at all (Kessides, 2012). The last thing that makes the market uncertain is that there isn't a proven track record. Very few SMRs have been built and used commercially, unlike traditional reactors. There aren't enough operational SMR units yet—like Russia's floating Akademik Lomonosov or China's HTR-PM—to convince regulators, investors, and utilities that they can be scaled up or will be economically viable in the long term. Stakeholders have been skeptical about the nuclear industry because it has a history of going over budget and being late. Until SMRs can show that they can be used successfully on a large scale, people won't trust the market. Workforce and Just Transition. Develop regional skills roadmaps, local training centres, and supplier-development programs so host districts capture jobs and SME opportunities. Social co-benefits (employment stability, apprenticeships, STEM education) reduce acceptance risk and strengthen the business case.

Public Opinion: Small Modular Reactors (SMRs) are a promising new technology in the nuclear energy field that could help solve the problems of climate change and energy security at the same time. SMRs are being praised by both the industry and governments as the next generation of nuclear power because they take up less space, can be built in modules, have better safety features, and can be deployed in a variety of ways. However, public support for SMRs is still mixed, mostly because of ongoing worries about nuclear waste, safety, and the risk of proliferation. These are issues that have historically affected how people view nuclear energy as a whole (Sine et al., 2020). Even though SMRs have made progress in technology, they still have to deal with the problem of radioactive waste, which is still a major concern for the public. Some SMR designs try to make less waste or use different fuel cycles, but there are still questions about how to store waste for a long time, how safe it is for the environment, and how fair it is for future generations. People are skeptical because there isn't a permanent disposal plan for high-level waste that everyone agrees on, and they are also worried that SMRs could make more waste streams by being used a lot (IAEA, 2022b). People often don't know the differences between SMRs and traditional reactors in great detail, and they may think that all nuclear technology has problems with waste that haven't been solved. People don't trust what the government says about how to handle waste, which makes this idea stronger (Slovic, 2010). Safety and security risks also affect how people see SMRs. SMRs use passive safety systems, are built underground, and have smaller fuel inventories to make them safer, but people are still wary because of past nuclear disasters like Chernobyl (1986) and Fukushima (2011). Not only technical facts, but also historical experience and institutional credibility have a big effect on how people see things (Sine et al., 2020). There is still a lot of uncertainty about how well SMRs will work in the real world because many of them are still being developed or tested. Also, the possibility of cyberattacks or sabotage, especially if SMRs are put in remote or less secure areas, raises more security issues (Baum et al., 2018). Many people might think that having several smaller reactors in different places would make things riskier, not less risky. The problem of nuclear proliferation is closely related to security. Some models of SMRs use high-assay low-enriched uranium (HALEU) or other fuel types that could, in theory, raise concerns about proliferation if they aren't properly protected. SMRs' ability to be moved and put together in different ways may make it harder for international monitoring and verification to do their jobs. Areas with political instability, a lack of openness, or a history of conflict make people more afraid. Even if the technology itself is meant to stop the spread of nuclear weapons, people's opinions can be affected by stories about politics and a lack of trust in international enforcement mechanisms (Lovering et al., 2020). People's support for a technology depends on more than just how safe they think it is; it also depends on how much they trust the organizations that manage and regulate it (Sine, Lee, et al., 2020). SMRs also have to deal with the "double burden" of perception: they have to overcome people's long-held fears about nuclear power while also showing that a new and untested technology is reliable. Most communities remain reluctant to host SMRs projects due to lack of a long history of commercial success. Therefore it is worth engaging people and communicating effectively. Opposition and distrust can be caused when the people are not engaged in decision-making, as previous researches have demonstrated (Fesenfeld et al., 2020). To enable the development of SMRs to have a popular acceptance, the technological reassurances alone is not enough; it needs the participatory governance and trust in the regulators. Social Acceptance Introduction. Conduct longitudinal surveys, deliberative polls, tracking sentiment post/hearing, publish dashboards on emergency preparedness exercises, near-miss reporting, and radiological monitoring to maintain transparency and accountability. Finally, Small Modular Reactors provide another approach to some of the issues nuclear energy has, and people are

another significant challenge. The issue of radioactive waste, safety and the danger of spreading nuclear weapons, which are some of the deep-seated issues in the greater nuclear debate, continue to influence the perception of SMRs. Nuclear innovation must be technically superior, but must also be capable of establishing and sustaining the public trust (Sine et al., 2020). If SMRs are going to be a clean and safe energy source, we need to deal with these issues through open government, open conversation, and honest rules.

Global Developments—

USA - The U.S. has given the NuScale Power Module the green light. Nuclear Regulatory Commission and is expected to be in use by the end of this decade (US NRC, 2020).

Canada- Canada backs several SMR projects as part of its SMR Roadmap. The country is interested in using them for mining and in communities that are hard to reach (Natural Resources Canada, 2020).

Russia- Russia's floating SMR, the Akademik Lomonosov, started working in 2020. China is working on the Linglong One (ACP100), which is meant for commercial use in the middle of the 2020s (IAEA, 2023).

Comparative Lessons for Planning- The experience of several countries reveals that the early host-community benefit compacts, regional industrial clustering (supply of fuel, fabrication and services), and open communication about cost-risks is what makes the difference to this long-run acquiescence. It is in a spatial location of nuclear projects in transport nodes (spatial strategy) and industrial corridors (spatial strategy) and water basins (spatial strategy) that spillovers are maximized and conflict minimized.

3. Strengthen uranium procurement through international partnerships—With the nuclear energy taking centre stage in the fulfilment of the clean energy objectives and energy security, the supply of a constant supply of uranium, which is the primary fuel in nuclear reactors, has become a concern. Many of the countries especially the countries who do not have adequate supply of uranium resources in their home countries like India, have to rely on partnerships with other countries to make sure that they have had a strong and diverse supply chain. Bilateral and multilateral partnerships are effective in enhancing uranium acquisition as a measure of protecting the growth in nuclear energy, alongside improving improved geopolitical stability, technology and best practice in regulation.

The Strategic Importance of Uranium Procurement-Uranium is the backbone of civilian nuclear power programs, and any alteration on the supply or price may have significant impact on the efficiency of nuclear reactors. To the emerging economies who desire to expand their nuclear fleets, a constant source of uranium is vital in maintaining the running of the reactors to achieve long-term goals of energy planning. Historically, not all nations, such as India, have been in a position to generate sufficient uranium to drive a massive reactor production (World Nuclear Association (WNA), 2023b). Connection to Domestic Social Outcomes. The long-term supply contract must contain provisions of local laboratories capacity, radiation-safety training and port/rail upgrades in the gateway areas. Publishing traceability and environmental safeguards across the fuel chain supports social licence at home and abroad.

Bilateral Agreements and Long-Term Contracts: Bilateral agreements for uranium supply have been very helpful in finding new sources and making sure that no one country or supplier is too important. Indones, as an example, has entered into long-term agreements with Kazakhstan, Canada, Australia, and Namibia, where the uranium reserves are huge, and the mining infrastructure is well-developed (Sundararajan, 2019). The 2015 Indo-Canadian accord was a breakthrough as it enabled Cameco to export uranium to India under the protection of IAEA. Australia and Kazakhstan negotiations have also made sure that the latter countries have a stable supply of strategic fuel and better connections to the world. Not only do such partnerships protect uranium, but often one element of these partnerships entails a plan to divide technology, nuclear fuel cycle services and training of nuclear professionals and all these are aimed at strengthening nuclear capacity. Geopolitical shocks, price fluctuations and unavailability of uranium in domestic markets are buffered with these agreements (Mishra and Raj 2020).

Multilateral Cooperation and Fuel Banks: Countries can also participate in multilateral arrangements, like the IAEA's Low Enriched Uranium (LEU) Bank in Kazakhstan, which provides strategic reserves that countries can use when the market is unstable. These programs create a global backup system that cuts down on the need to stockpile and makes sure fuel is always available, even during politically sensitive times (IAEA, 2019). Also, being part of international groups that look for and mine uranium, such as joint ventures in Africa and Central Asia, can help ensure a steady supply while also giving people a chance to work together to protect the environment and govern.

Geopolitical and Regulatory Considerations—Working with other countries to buy uranium is also very important from a geopolitical point of view. These partnerships often help with nuclear

diplomacy, bringing countries like India more fully into the global nuclear order even though they are not signatories to the Non-Proliferation Treaty (NPT). Transparent, IAEA-compliant procurement under international safeguards builds trust, makes it easier for foreign investors to put money into India, and helps India reach its net-zero emission goals (WNA, 2023).

International partnerships also give you access to the best safety, transportation, and regulatory practices from around the world, which makes the nuclear fuel cycle stronger and more accountable. Environmental Justice. Adopt sourcing policies that recognise Indigenous and local community rights in mining regions, require free, prior and informed consent (FPIC), and commit to independent environmental audits. Ethical procurement improves public perception and aligns nuclear expansion with equitable development. Countries with strong nuclear industries can share what they know about waste management, uranium enrichment standards, and supply chain ethics. This knowledge makes domestic capabilities and institutional frameworks stronger.

4. Allocate resources towards Public Communication and Nuclear Safety Education- Nuclear power is becoming more and more important as the world needs more clean, reliable, and low-carbon energy. But for nuclear energy programs to be successful and grow, they need more than just new technology and rules. They also need the public to accept them. Fear, false information, and a lack of knowledge about nuclear science have shaped how people have thought about nuclear energy in the past. So, to build trust, clear up misconceptions, and get people involved in nuclear policy and projects, it's important to put money into educating the public about nuclear safety and how to communicate with them.

The Role of Public Communication in Nuclear Acceptance—Effective public communication is a strategic necessity for nuclear energy programs. Clear, consistent, and science-based communication helps people understand the pros and cons of nuclear energy. People are more likely to support the use of nuclear power when they know how it can help lower greenhouse gas emissions, make energy more secure, and boost economic growth (Sine et al., 2020). Also, clear communication is very important during nuclear accidents or controversies because bad messaging can cause panic, political backlash, and loss of trust in institutions.

Lack of transparency and false information are two of the main reasons why people are against something. People's perceptions of risk are often based on their feelings and past events like the Chernobyl (1986) and Fukushima (2011) accidents (Slovic, 2010). These events not only made people more afraid of nuclear safety, but they also showed what happens when authorities don't communicate well. To get over historical distrust and stop the spread of nuclear-related myths, it's important to come up with communication strategies that are proactive, open to everyone, and aware of cultural differences.

Building a knowledgeable society through nuclear safety education: Just like public communication, investing in nuclear safety education is essential for building a society that can engage constructively with nuclear issues. Nuclear education shouldn't just be for technical professionals; it should also be for schools, universities, community leaders, and media professionals so that everyone is well-informed. Adding basic nuclear science, radiation awareness, and safety procedures to school curricula can make the subject less mysterious and encourage students to think critically (IAEA, 2021b). For countries like India, where nuclear energy is an important part of the national clean energy strategy, it is very important to create academic and vocational programs that focus on nuclear science and safety. Building more nuclear education facilities, especially in public and regional schools, can help solve the problem of not having enough skilled workers and also make the public more aware of nuclear issues. Public lectures, outreach programs, facility visits, and working with civil society groups can all help people understand and get involved even more (Kumar and Saran 2019). Structured Engagement Plan. Establish a three-tier model: (i) national myth-busting campaigns and curriculum modules; (ii) state/district risk-communication cells with drill calendars; (iii) site-level community liaison committees publishing monthly dashboards (ambient radiation, water quality, drill performance, grievance resolution).

Institutional Trust and Participatory Dialogue—People's trust in nuclear institutions like governments, regulators, and operators is closely linked to how open and clear they are. Some people also say that public trust is not just based on technical assurances, but also on how legitimate and accountable institutions seem to be. So, it's important to put money into two-way communication, where the public is not just a passive recipient of information but also an active participant in discussions (Sine, Lee, et al., 2020). Citizen forums, public consultations, and participatory decision-making processes are some of the ways to build legitimacy and a social license to operate. Also, independent oversight bodies and working with international organizations like the International Atomic Energy Agency (IAEA) can help people trust

that safety standards and emergency preparedness are good. People are more likely to support or accept nuclear power plants when they know that they are being closely watched by the international community (IAEA, 2022a). Evaluation Metrics. Track trust indices, participation rates, drill compliance, grievance closure times, and independent audit scores; disclose results publicly. Continuous measurement links engagement to policy improvement and sustained acceptance.

5. Integrating nuclear energy with renewable energy sources for a balanced energy mix—The need to decarbonize the world's energy system and make sure it is secure for the long term has brought back attention to how important it is to have a balanced and resilient energy mix. Renewable energy sources like solar, wind, and hydropower have grown quickly, but they have problems with intermittency, land use, and resource variability. In this situation, nuclear energy stands out as a low-carbon source that can provide reliable, on-demand power. Combining nuclear energy with renewable energy sources can make an energy portfolio that is reliable, sustainable, and resilient—all of which are important for reaching net-zero emissions goals.

Nuclear and renewables work well together. Territorial Energy Planning. Co-locate nuclear baseload with industrial demand hubs and situate VRE (solar/wind) in resource-rich districts, connected by planned transmission corridors and industrial parks. This spatial design minimises curtailment and spreads growth beyond core metros. A lot of individuals believe that nuclear energy and renewables are two competing technologies. However, in the real world, their characteristics can be united to achieve the grid even more stable. Nuclear energy is a reliable, electric power with high capacity factors (typically exceeding 90 percent) that produces very low greenhouse gasses. Renewable energy on the other hand varies with the weather and seasons. This swing may lead to grid issues such as power outage or excessive dependence on fossil fuel stocks, unless there is another source of energy such as nuclear energy (International Energy Agency (IEA), 2020).

The next option of collaboration is the high nuclear technologies, such as Small Modular Reactors (SMRs). They are not only able to follow loads and handle wide loads, but are also suitable to operate under the variable renewable energy (VRE). SMR has the capability of running on partial loads, ramp up, and providing power and heat to the industry. This enables the more flexible nature of the energy systems (World Nuclear Association (WNA), 2023).

Energy Security and Decarbonization Goals—For many countries, combining nuclear power with renewable energy is a way to make the energy mix more diverse, rely less on fossil fuels, and give people more control over their energy supply. This is especially true in countries where it is hard to get to reliable renewable resources or grid-scale storage technologies. A diverse energy portfolio lowers the risks of relying too much on one source and protects national energy systems from market fluctuations, supply interruptions, and geopolitical tensions (Rogner & Abdel-Aziz, 2022). It is important to include nuclear energy in order to reach the Paris Agreement's goal of limiting global warming to 1.5°C. The Intergovernmental Panel on Climate Change (IPCC, 2022) says that to reach global net-zero, we need to use more renewable energy and more low-carbon baseload power, like nuclear. France and Sweden are two countries that have quickly reduced their carbon emissions. They have done this by using a mix of nuclear and hydro power, which shows that nuclear-renewable integration is possible.

Grid Modernization and System Flexibility—To make integration work, the energy infrastructure needs to be updated so that it can handle different types of generation sources. Smart grids, real-time demand management, and energy storage systems are all important for making sure that nuclear and renewable energy sources can work together instead of against each other. Nuclear plants can help keep the grid stable and control its frequency, while renewable energy sources can provide extra power during peak times, like during the day or when it's windy. Additionally, nuclear plants can be converted to make green hydrogen through electrolysis, which will help decarbonize sectors that are hard to decarbonize, like steel and heavy transport (IAEA, 2022).

Regional Instruments- Use State Energy Development Plans, special investment regions, and brownfield industrial retrofits to steer siting. Integrate projects of integration and tariff subsidies within low-income districts and local hiring requirements, as well as reskilling funds and place the transition into a socially fair development.

The notion of investing in a hybrid systems of energy wherein nuclear, renewable, and storage are all found on a single location or at an interconnected location is a good idea. To provide an example, solar-powered photovoltaic (PV) battery-powered SMRs can be used to supply fixed baseload power, as well as peak demand power, in an efficient fashion, particularly in off-grid or remote communities.

Public Perception and Policy Alignment—Although technically, nuclear and renewables can be merged, there has to be policy frameworks, long-term planning, and faith in the people to merge. When the development of nuclear energy seems to have a technical account, the development is usually halted through political rhetoric and mass demonstrations. In this regard, the governmental policy must support the introduction of clean energy that is independent of a specific technology and help to generate new concepts about nuclear safety, waste management, and grid integration. Engaging the citizens and proper risk communication are highly essential to make people accept an integrated approach to low-carbon energy (Sine et al., 2020).

Conclusion

Nuclear energy could be very important for India's plan to switch to clean energy and ensure it has enough energy. It also plays a vital role in shaping social outcomes, influencing regional development, employment generation, and equitable access to clean energy. Nuclear power can help India build a strong, low-carbon energy future along with renewable energy sources if the right policies are in place, the public is involved, and countries work together. Combining nuclear power with renewable energy is a practical, dependable, and low-carbon way to make a balanced energy mix. Nuclear power is reliable, and renewable energy is sustainable. When these two types of energy are used together, they can make up for the weaknesses of each other. As countries work toward net-zero emissions, it is important to strengthen the synergy between nuclear and renewable energy by modernizing infrastructure, changing policies, and getting the public involved. A well-integrated system will not only protect energy security, but it will also keep climate promises and the economy strong. Also, changing the liability system is a strategic and legal must if we want to get foreign companies to invest in the nuclear energy sector. Countries that want to meet their clean energy and climate goals need access to cutting-edge technologies, financing, and global supply chains. This will be facilitated by a predictable, internationally consistent, and investment friendly framework. Simultaneously, reforms should ensure that the people do not lose their trust and fairness and accountability principles are maintained. Simultaneously, the reforms should contribute to the creation of the public trust, as the reforms should be transparent in their decisions, participatory in their governing, and respect the principles of justice and accountability. We can accomplish these two objectives by ensuring that the law is clear and providing institutions with the means to carry out their work. This will result in more integrated and global nuclear future. The SMRs will provide a vast number of technical opportunities going forward, but they will not be sold due to the long-held market uncertainty. All governments, businesses and international organizations will be forced to collaborate in order to address these uncertainties. Sharing financial risk, demonstration projects supported by the government, clearer market signals, and energy planning that consider all of these things need to be created to establish a viable market in SMRs. Unless such measures are taken, the SMRs will remain just a piece of paper, and will be incapable of realizing the potential of energy systems in the future. The countries that are interested in increasing their nuclear energy safely and in a sustainable manner need to cooperate with other countries so that they may be able to obtain uranium easily. These alliances do not just achieve the procurement of fuel but they also provide the diplomatic relations, technological facilities and confidence in the international nuclear community. The uranium supply chain that is formed by effective international cooperation and with a long-standing history will be one of the pillars of nuclear energy policy as the countries will be moving towards decarbonization and becoming an energy-independent country. And finally long-term existence of nuclear energy demands a long-term dedication of informing an individual and educating them on the security of nuclear energy. Technical and regulatory frameworks will be involved in safe operations but the wisdom and faith of the people will ultimately decide whether nuclear power is socially acceptable or not. Governments, businesses, and schools must work together because they all require improving communication, education and open dialogue. The inclusion of the nuclear expansion in the broader spatial planning and regional development policies will also ensure that the benefits are equally distributed to the different regions of the country. A well-informed and involved audience can not only be less prone to fear or misinformation, but other valuable contributions to national energy discussions and decisions are also possible.

References

1. Baum, S. D., Barrett, A. M., & Hostetler, K. (2018). Risk and resilience in nuclear infrastructure. *Risk Analysis*, *38*(2), 267–276.
2. Bhaduri, A A., & Deshpande, A. (2022). Nuclear Energy and Energy Security in India: Reimagining Strategy Post-Paris Agreement. *Energy Policy*, *162*, 112781.
3. Fesenfeld, L. P., Wicki, M., & Sun, Y. (2020). Public acceptance of nuclear power: The importance of stakeholder inclusion and transparency. *Energy Policy*, *146*, 111793.
4. Ingersoll, D. T., Houghton, Z. J., Bromm, R. A., & Qvist, S. A. (2014). Can small modular reactors expand nuclear power? *Nuclear Technology*, *186*(2), 223–238.

5. Intergovernmental Panel on Climate Change (IPCC). (2022). *Sixth Assessment Report: Mitigation of climate change*. Retrieved May 20, 2025, from https://www.ipcc.ch/report/ar6/wg3/
6. Intergovernmental Panel on Climate Change (IPCC). (2023). *AR6 Synthesis Report*. Retrieved June 12, 2025, from https://www.ipcc.ch
7. International Atomic Energy Agency. (2022). Climate Change and Nuclear Power 2022. In *https://www.iaea.org*.
8. International Atomic Energy Agency (IAEA). (2019). *LEU Bank of IAEA officially opened in Kazakhstan*. Retrieved April 12, 2025, from https://www.iaea.org/newscenter/news/leu-bank-of-iaea-officially-opened-in-kazakhstan
9. International Atomic Energy Agency (IAEA). (2021a). Advances in Small Modular Reactor Technology Developments. In *https://www.iaea.org*.
10. International Atomic Energy Agency (IAEA). (2021b). *Education and training in nuclear safety*. Retrieved March 30, 2025, from https://www.iaea.org/topics/education-and-training-in-nuclear-safety
11. International Atomic Energy Agency (IAEA). (2021c). *Nuclear law: The global debate on civil liability for nuclear damage*. Retrieved May 11, 2025, from https://www.iaea.org/topics/liability-for-nuclear-damage
12. International Atomic Energy Agency (IAEA). (2022). Nuclear energy for a net zero world. In *https://www.iaea.org*.
13. International Atomic Energy Agency (IAEA). (2022a). *Nuclear safety review*. Retrieved June 20, 2025, from https://www.iaea.org/resources/safety-standards
14. International Atomic Energy Agency (IAEA). (2022b). *Small modular reactors: Technology and safety assessment*. Retrieved April 12, 2025, from https://www.iaea.org/topics/small-modular-reactors
15. International Energy Agency. (2021). *India Energy Outlook 2021*. Retrieved June 15, 2025, from https://www.iea.org/reports/india-energy-outlook-2021
16. International Energy Agency (IEA). (2020). *Nuclear power in a clean energy system*. Retrieved April 30, 2025, from https://www.iea.org/reports/nuclear-power-in-a-clean-energy-system
17. Kessides, I. N. (2012). The future of the nuclear industry reconsidered: Risks, uncertainties, and continued promise. *Energy Policy*, *48*, 185–208.
18. Kumar, R., & Saran, A. (2019). Strengthening nuclear education in India: A policy perspective. *Energy Strategy Reviews*, *26*, 100384.
19. Kuznetsov, V., & Lokhov, A. (2011). Small Modular Reactors for Energy and Non-Electric Applications. In *OECD Nuclear*.
20. Locatelli, G., Mancini, M., & Eniya, A. (2017). Why are Small Modular Reactors attractive? *Energy*, *112*, 636–647.
21. Lovering, J. R., Yip, A., & Nordhaus, T. (2020). Historical construction costs of global nuclear power reactors. *Energy Policy*, *91*, 371–382.
22. Ministry of Power, Government of India. (2023). National Electricity Plan 2023–32. In *https://powermin.gov.in*.
23. Mishra, A., & Raj, A. (2020). India's nuclear energy program: Challenges and future directions. *Energy Policy*, *140*, 111435.
24. Misra, A. (2019). Revisiting India's nuclear liability regime: Prospects for reform. *Indian Journal of International Law*, *59*(2), 227–244.
25. Natural Resources Canada. (2020). Canada's SMR Action Plan. In *https://www.nrcan.gc.ca*.
26. Nuclear Energy Agency (NEA). (2021). Small modular reactors: challenges and opportunities. In *https://www.oecd-nea.org*.
27. Nuclear Energy Agency (NEA). (2021). Small Modular Reactors: Challenges and Opportunities. In *https://www.oecd-nea.org*. OECD/NEA.
28. Raj, A., & Narain, M. (2020). Civil nuclear liability in India: Balancing accountability and investor confidence. *Energy Policy*, *146*, 111754.
29. Rogner, H. H., & Abdel-Aziz, A. (2022). The role of nuclear-renewable energy integration in sustainable development. *Energy Policy*, *164*, 112871.
30. Sine, W. D., David, R. J., & Mitsuhashi, H. (2020). Public perceptions and nuclear technology: Evidence from SMR markets. *Journal of Environmental Management*, *254*, 109818.
31. Sine, W. D., Lee, B. H., & Suchman, M. C. (2020). Legitimating nuclear power: How institutional frames affect public perception and industry regulation. *Organization Science*, *31*(5), 1200–1223.
32. Slovic, P. (2010). *The perception of risk*. Earthscan.
33. Sundararajan, K. (2019). Strategic fuel security: India's uranium import policy and bilateral ties. *Strategic Analysis*, *43*(5), 425–437.
34. US Nuclear Regulatory Commission (NRC). (2020). Final safety evaluation report for the NUScale Small modular reactor. In *https://www.nrc.gov*.
35. World Nuclear Association. (2024). Nuclear power in India. In *https://world-nuclear.org*.
36. World Nuclear Association (WNA). (2023a). *Civil liability for nuclear damage*. Retrieved June 15, 2025, from https://www.world-nuclear.org/information-library/current-and-future-generation/civil-liability-for-nuclear-damage.aspx
37. World Nuclear Association (WNA). (2023b). *Nuclear power in India*. Retrieved February 20, 2025, from https://www.world-nuclear.org/

information-library/nuclear-fuel-cycle/nuclear-power-reactors/small-nuclear-power-reactors.aspx

38. World Nuclear Association (WNA). (2023). Small Modular Reactors. In *https://world-nuclear.org*. Retrieved July 4, 2025, from https://www.world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-power-reactors/small-nuclear-power-reactors.aspx

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Research Article

India's Nuclear Policy: Evolution And Perspectives

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ABSTRACT

The establishment of the Indian nuclear energy program, which serves both covert military applications and overt civilian purposes, may be attributed mostly to a favorable confluence of individuals, events, locations, and global trends. India must have an unquenchable ambition to meet its energy needs, given its ambitious development plans. Energy-driven policies always hover around the question of how to raise energy production and consumption. Nuclear energy appears to be a promising option for matching India's energy deficit. India is in the most dangerous, unstable, and anarchic region of the world due to social unrest, political unrest, economic violence, and religious and political warfare in a number of failed or collapsing neighboring governments, which has driven India to pursue the development of nuclear weapons. The main argument of this paper is to study and analyze India's nuclear legal framework, various regulatory mechanisms, energy programs and overall assessment of the nuclear continuity and change over time under various political parties.

Methodology- In order to study India's unwavering drive to meet its energy needs in both the civilian and military domains, we will be dealing with value-based posers, hence the proposed topic cannot afford to be constrained by the restrictions of scientific or behavioral research. Here, we shall mostly stick to a philosophical, historical, and analytical perspective. Data, facts and historical evidence already available will also be used freely and judiciously wherever necessary. In this context, it would be better to begin with an open mind and use all possible means of research to find the truth and the viability of the purposes.

Keywords- Nuclear energy, Indo-US Nuclear Deal, Energy production, Energy deficit, Political leaders

Introduction

India embarked on the nuclear path through research and active electricity generation long before independence. Ashok Kapur, an eminent scholar, claims that it was in the early 1930s that the Indian attitude to science policy in general, and nuclear power in particular, emerged (Kapur, 2001). The Indian nuclear program was launched before March 1944, more than three years before India gained independence from the British (Salik, 2009). It got an impetus in 1944 with the establishment of the Tata Institute of Fundamental Research under the guidance of Dr. Homi J. Bhabha who also happened to be the first Head of Atomic Energy Commission (Sharma, 1986). The Atomic Energy Commission was established in 1948 responsible for control of technological as well as administrative particulars of nuclear research activities with an intent to make India self-sufficient in the area of energy. The years 1947 to 1964 are extremely significant for the study of India's Nuclear history. Indian attitudes and policies were formed at this time and these shaped the contours of India's Nuclear strategy in the coming decades. India's nuclear policy is primarily civilian focusing on power as well as non-power application of nuclear energy and subsequently, changed its contour due to security threats stemming from China and Pakistan thus the addition of military aspect became inevitable (Kapur, 2001). The period also witnessed the establishment of the Department of Atomic Energy (DAE) in 1954. By 1958, significant and quick progress had been made in research and development (R&D) for the peaceful use of atomic energy. DAE includes every field pertaining to atomic energy applications, both power and non-power. The department's mission is to develop nuclear energy technology, including waste management, construction

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and operation of nuclear power plants, heavy water production, identification and processing of atomic minerals and uranium resources, nuclear fuel fabrication and production of reprocessed nuclear fuel. The DAE is also responsible for R&D in the fields of advanced instrumentation and electronics, biological sciences, materials science, fast reactor and fusion technologies, accelerator and laser technologies, etc. In non-energy applications of atomic energy, the department carries out leading-edge R&D into the use of radiation technologies and isotopes in the fields of food and agriculture, health, environment and industry.
DAE is at the forefront of R&D because of the powerful synergy that exists between technological development and R&D in several important core disciplines that are both national and global in scope. For societal uses including food preservation, clean water, advanced crop and seed types, urban waste management, etc., DAE kept developing and implementing spin-off technologies.
In the context of India's Nuclear policy, there have historically been elements of both continuity and change, which are discernable once we go through the various phases. At the level of setting up the necessary infrastructure and the activities of the scientific and technological establishment, one can observe continuity and a stable development over the decades, spearheaded by different Prime Ministers from various political parties. This paper highlights the various phases in order to understand the policies and mechanisms for meeting energy demand, with a specific focus on Nuclear Energy.
The various phases under different Prime Ministers are given as under:

JawaharLal Nehru Phase (1947-1964)

Being the first Prime Minister of India, Pt. J L Nehru made the sincere effort to make India self-sufficient soon after independence. The dawn of India's Nuclear program coincided with the kicking off of the industrial infrastructure in the country. India's nuclear policy took a concrete shape in the year 1948, when the Atomic Energy Bill was piloted. In April 1948, while proposing the Atomic Energy Bill in the Constituent Assembly, Jawaharlal Nehru stated that atomic energy was a vast source of power and if we were to remain abreast with the world as a nation, we should develop atomic energy and use it peacefully (Sharma, 1986). The underdeveloped countries cannot afford to forego an opportunity to develop nuclear energy for industrial purposes, nor can they allow any international body dominated by the industrially advanced countries to decide their activities in regard to the development of fission energy (Sharma, 1986). In May 1954, Nehru restated in the Lok Sabha that it was important for a power-starved nation like India or most other Asian and African nations to make maximum utilization of atomic energy for peaceful purposes (Sharma, 1986). Nehru emphasized upon the expansion of atomic energy in India and associated it with the building of a free and self-reliant India (Raja, 2016). Nehru insisted on the utilization of nuclear energy for the development of human life and happiness. Nehru identified India with the spirit of humanity and was convinced that in the world of opposite uses that nuclear power represents, India would always prefer the spirit of humanity over the building up of an atom bomb.
Pt. Nehru and Dr. Homi Bhabha were the persons who spearheaded the development of India's nuclear power program in its early years, highlighting the importance of nuclear energy for the nation's prosperity and development and advocating for its use for peaceful purposes only. Bhabha adamantly said that, should it want to do so, India could produce an atomic bomb in two years. Though its philosophical and scientific challenges were the main driving forces behind the creation of the first Atomic Energy Act of 1948, Bhabha never lost sight of the military benefits of nuclear energy and was greatly fascinated by its destructive power. Dr. Bhabha also stated that coal and hydropower resources alone would not be able to meet India's energy needs. In 1958, he proved that the most important consideration for evaluating atomic energy's relative usefulness was "not the relative cost of power plants, but the relative total cost to the economy as a whole of providing progressively larger amounts of new power." (Bhabha, 1958).
Nehru had committed all future governments of India to the use of nuclear energy exclusively for peaceful purposes.
Establishment of Civilian Nuclear facilities -- Serious development started in 1954 with the start of construction on the Bhabha Atomic Research Centre (BARC) at Trombay. BARC served as India's primary research facility for its nuclear program. In addition, there was a significant increase in government support for atomic research during this period, and there was also a greater push for international scientific collaboration.
In 1955, the Bhabha Atomic Research Centre (BARC) designed the APSARA research reactor, which was built with the assistance of the United Kingdom. The purpose of constructing the 1 MWt APSARA research reactor was to launch research into reactor physics and engineering. In 1954, Canada supplied India with the Canada India Reactor Utility Services (CIRUS), 'a heavy-water (deuterium oxide) moderated research reactor' for which the US accepted to provide heavy water under the auspices of the "Atoms for Peace" program. The CIRUS reactor was the first source of fissile material to attain criticality in July, 1960. Despite being presented as peaceful, CIRUS was used to produce most of the weapons-grade plutonium that was used in the first nuclear test in India.

Some of the early Power Reactors

Tarapur Atomic Power Station (TAPS- 1 & 2) India benefited in the early 1950s from its first international collaboration in the nuclear sector, when it was given the chance to train its engineers and scientists in the US.

Bhabha then expressed interest in expanding Indo-US collaboration to the eventual supply of US power reactors to India. It became evident that India's interest in nuclear power production was driven more by a desire to secure the best financial conditions from the US and to bring nuclear power production into the nation as quickly as feasible than by a preference for light-water reactor (LWR) technology.

Rajasthan Atomic Power Station (RAPS- 1&2)- Approximately concurrently with its negotiations with the United States, Bhabha had also begun exploring the possibility of building nuclear reactors in collaboration with Canada. India had already gained from Indo-Canadian cooperation on the CIRUS Project, particularly in the field of heavy-water reactor technology. A nuclear program between India and Canada was discussed as a result of this interaction and the fact that heavy water reactors were the initial phase of the Bhabha plan. The establishment of a 200MWe PHWR power plant in Rajasthan was agreed upon by India and Canada in April 1964.

Madras Atomic Power Station (MAPS-1 & 2) -The DAE's PPED was designing a win-reactor station to be built at the Madras Atomic Power Station (MAPS-1 & 2) in south India, concurrently with the development of the Rajasthan Power Station. Apart from a few significant modifications made by the DAE experts, the MAPS reactors were essentially quite identical to the RAPS units.

Narora Atomic Power Station (NAPS-1&2).

Reactor safety enhancements that were lacking in the design of the Canadian reactor were among the modifications implemented in NAPS. NAPS-1 was commissioned in January 1991 and NAPS-2 in July 1992.

Kakrapar Atomic Power Station (KAPS)

In May 1993, KAPS-1 entered into commercial service. It was decided that the Indian 220MWe (gross) PHWR system had reached full maturity when KAPS-2 achieved a comparable level in May 1995. Alongside its other accomplishments, India built eight heavy water production facilities by 1995, making it self-sufficient in this essential component for the PHWR program.

Kaiga Station and the RAPS Extension.

The Indian nuclear power program eventually came out of the shadows of international sanctions after more than twenty years of resolute work, primarily to keep India from achieving this capability level. The government's excitement for authorizing more 220 Mwe PHWR stations and funding future advanced reactor projects became apparent as the program approached this milestone. In response, the Kaiga Atomic Power Station (KGS-1 & 2) and two further reactors in Rajasthan with a similar rating (RAPS-3 & 4) were established. These four reactors began to operate commercially in March and December of 2000.

Lal Bahadur Shastri Phase (1964-1966)

The 2nd phase of India's nuclear trajectory coincided with Lal Bahadur Shastri's reign, and during this period the demand for having nuclear India got a boost, particularly following India's debacle in 1962, and Chinese explosion in 1964. This period witnessed the emergence of two schools of thought, with one warning against the diversion of economic resources to the manufacture of nuclear weapons. Adherents of this school of thought echoed the necessity of general and complete disarmament on a comprehensive basis. The second school of thought clamored for a more deterrent role for India**.** Consequently, a ginger group emerged within the congress party under the premiership of Mr. K.C. Pant, urging India to revisit its traditional Nuclear Policy. The group also demanded choosing the nuclear option under compelling backgrounds like the Indo- China War, the Chinese explosion in 1964, the Indo- Pak War of 1965, and the growing collaboration of Pakistan with China, which became vehement. The mounting pressure forced Shastri to switch from the traditional stance of developing and using nuclear energy solely for 'peaceful ends' to a change in government policy from 'no bomb ever' to 'no bomb now' (Chakma, 2005). Hence, the Subterranean Nuclear Explosion Project (SNEP) as proposed by Homi. J. Bhabha was approved by Lal Bahadur Shastri. The line of action after the sudden death of a strong-willed political leader was further strengthened and enabled the entire Indian nuclear program to continue.

Indira Gandhi Phase: Pokhran I & India's Entry into the Nuclear Club (1966-1977)

Lal Bahadur Shastri was succeeded by Indira Gandhi in January 1966. Indira Gandhi, after assuming office, clearly indicated that she would not go for the nuclear weapon option and even shelved her predecessor's project Subterranean Nuclear Explosion Project (SNEP), but soon after her assumption of the office, China went for its third nuclear explosion. Thus, echoing the domestic demand for having our own nuclear bomb. In reaction to these tests, Indira Gandhi said in the Lok Sabha that India will expand its nuclear technological know-how and "other competencies" in addition to using atomic power for "peaceful" purposes. Bhumitra Chakma remarked that her initial policy stance was soon changed as developments with huge ramifications occurred beyond India's border (Chakma, 2005). The nuclear narrative in India from 1964 to 1974 was highly remarkable because of the heightened interplay and tension between exterior and interior pressures in Indian nuclear decision-making. During this period, the Indian government was faced with three main concerns namely: -

I) Whether India should sign the NPT (1967-68). After an internal debate, India refused to sign the NPT due to its discriminatory nature. It seeks to deny the freedom to Non-Nuclear Weapon States (NNWS) to acquire nuclear weapons and does not ask Nuclear Weapon States to destroy or restrict their armaments.

II) Whether India should accept the weak US-Soviet security assurances through the UN Security Council (1968) and
III) Whether to have a Peaceful Nuclear Explosion (this concern has been in debate since 1965).

Smiling Buddha - India's first Nuclear Explosion (1974)

The first peaceful nuclear explosion, popularly known as Operation Smiling Buddha, took place in May 1974 and was a step towards weaponization. Nevertheless, this explosion enabled India to become a de facto member of the Nuclear club. The international response to India's nuclear explosion varied from gentle to harsh. Canada, the US and Pakistan launched a scathing attack and condemned the explosion in the strongest words. Canada stopped funding India's nuclear program (Alam, 1988) and brought Rajasthan II and Kota heavy water plants to halt. The US regarded the action as a breach of the terms on which aid had been provided to India.

Morarji Desai (1977-1979)

The 1977 General Elections brought the Janata Party-led coalition into power. The new Prime Minister, Morarji Desai, was an old Congress hand committed to the Gandhian principles of non-violence and known to be instinctively anti-nuclear. Morarji Desai, a senior Gandhian follower, was an opponent of nuclear weapons on moral grounds and considered them as evil. He had a firm belief that cottage industry was more useful to India than its nuclear program (Karnad, 2008). He publicly promised that India would not conduct nuclear tests during his tenure and would focus on a peaceful nuclear explosion. Desai's coalition government collapsed in 1979. He was adamant that India would not sign the NPT because it was unfair, and he was vehemently opposed to nuclear weapons. Both stances represented India's moral self-image and its aim to publicly declare and illustrate its moral superiority over the Cold War nations. Even though Pakistan was preparing to begin building the Kahuta uranium enrichment plant, the pro-bomb Jana Sangh leaders, including the then-foreign minister AB Vajpayee, supported this nuclear program (Perkovich, 1999).

Charan Singh (1979-1980)

It was Pakistan's covert atomic ventures and Afghanistan's invasion by the Soviet in 1979 which led Prime Minister Charan Singh to alter Desai's ironclad commitment not to acquire nuclear weapons. Hence it signaled a change in the policy.

Indira Gandhi comeback (1980-1984)

Shortly after taking office again in 1980, Indira Gandhi disregarded Desai's pledge to refrain from testing nuclear explosives and chastised him for disobeying the nuclear establishment's interests and recommendations (Perkovich, 1999). Meanwhile, India was relegated to the backbench in South Asia and had lost all strategic and nuclear relevance in 1981, as the US moved closer to the two countries (Pakistan and China) in an attempt to encircle India (Cohen, 2001). A stronger stance may have been justified by external security concerns, which included the following: the Soviet Union was well into its war in Afghanistan; Pakistan was steadily moving towards the development of a nuclear weapon program; the United States was giving Pakistan significant military support; and China was strengthening its relations with Pakistan, partly in response to the Soviet Union's advance into Southwest Asia. Nevertheless, a significant portion of the focus that Indian officials placed on nuclear policy during this period was on negotiating with Washington to avoid the congressionally mandated shutdown of nuclear fuel for the Tarapur reactors (Perkovich, 1999). India amplified its reliance on Russia by indulging in the largest conventional arms-buying spree in the sub-continent history. Simultaneously, India started developing an Integrated Guided Missile Program (IGMP) in 1983 (Charynsh, 2006). Similarly, the 80's and 90's witnessed increased numbers of nuclear weapons and the introduction of sophisticated delivery systems in India's neighborhood as a result of missile and nuclear proliferation, which deteriorated India's security environment (Ganguly, 1999).

Rajiv Gandhi (1984-1989)

India preferred global nuclear disarmament over nuclear weapons. In his view, the nuclear establishment had likewise failed terribly to deliver on its pledge to supply cheap and plentiful electricity to support India's economic growth. India's caution was partly motivated by a desire to maintain high-tech collaboration with the United States without interference. He felt that developing technological know-how and resources across the board, with American assistance, would be more important to India's eventual prosperity and power than concentrating on nuclear weapons (Perkovich, 1999). India's challenge to being in a position of strategic irrelevance was met through political and conventional military instruments. It was during his tenure as Prime Minister that India embarked on a program of defense modernization and military expansion (Zaman, 2009).

From 1974 Nuclear Test to Pre-May 1998 Period

The period between 1974 nuclear test and pre-May 1998 has not witnessed any significant decision making concerning nuclear and missile activity. The period has been marked by a complex internal and international environment. Domestically speaking, the Indian political system was marked by unstable and weak coalitions which restrained the governments from taking any concrete step (for example, those of Prime Ministers

Narasimha Rao, V. P. Singh, Deve Gowda, and I. K. Gujral) and at the same time, in the international arena, arms control arrangements-NPT, Missile Technology Control Regime (MTCR), Comprehensive Test Ban Treaty (CTBT), and Fissile Material Production Ban- were taking shape, but as they were politically and technically discriminatory in nature, India remained aloof from them.

P V Narasimha Rao (1991-1996)- A coordinated nuclear weapons production program was not approved by Rao. India's nuclear policy remained neutral, but its nuclear capacity remained limited, clandestine, and so unclear (Perkovich, 1999). To strengthen India, the Rao administration considered economic growth and integration into the world economy to be more crucial than nuclear weapons (Perkovich, 1999).

A B Vajpayee (1998-2004)- Crossing the Nuclear Rubicon

It was only in 1998 when BJP returned to power, that it declared India to be a nuclear weapon State. Following the 1998 nuclear tests, India announced a nuclear doctrine based on the principles of no-first use, command and control and credible minimum deterrence. The Pokhran tests in May 1998 marked a dramatic shift in India's nuclear posture. It brought India's nuclear capability from the realm of a quiet and covert military program to that of a public status. The tests were not well received by the international community and were condemned by various countries. Huge economic sanctions were imposed on India by the US and international pressure increased for India to join the discriminatory Non-Proliferation Treaty (NPT) and the Comprehensive Test Ban Treaty (CTBT) were on rise.

Manmohan Singh UPA-I and II (2005-2014)

Harison Brown, an American Nuclear expert, wrote in the Introduction to the Report on the Regional Economic Development of Nuclear Power in India: It seems clear that India's ultimate energy resources are insufficient to permit it to successfully negotiate the industrial transition. This means that if India is to succeed in its development plans, it must eventually shift from a dependence upon coal, petroleum and water power as energy resources to a dependence upon nuclear energy. India with teeming millions of populations having no connectivity to the power grid, has a lot of work to do to bridge its energy deficit. The Niti Aayog of India has projected that by 2032, India's total primary energy demand would increase threefold of 2010 supply. Under the current policy structure, India is going to face an eminent energy crisis in the next decade in order to sustain targeted Economic Growth of 8 to 10 percent required for eradicating poverty and meeting the sustainable development goals. The boulevard of energy centric policies will be the determining force of India's rapid growth. Meeting energy requirements, be it nuclear energy or any other form of energy, is considered as a leading stimulant for raising the modus vivendi of citizens of any country being inextricably linked with the index of human development (HDI). Nuclear energy can be considered as an important source of energy for India if its additional advantages of huge growth potential and carbon neutrality are taken into account. In order to achieve this objective, it becomes imperative for any country to establish nuclear cooperation relations with other countries, and India is no exception. Nuclear relationships are essential for achieving India's development goals. The countries that most often have nuclear relationships with India are the US, Canada, Russian Federation, the UK, Japan, France, Australia, South Korea, Argentina, Kazakhstan, and Namibia. India started its nuclear program with the intention to use it for peaceful purposes, and Canada and the US were the first countries that helped India with this program.

The first United Progressive Alliance (UPA) government under Manmohan Singh stewardship takes the civil nuclear deal of 2008 as the pinnacle moment not only in Indo-US relations, but also in the Nuclear history of contemporary India. By virtue of the agreement, India has been recognized as a de-facto nuclear power, and the United States has set aside its semicentennial old policy of subduing New Delhi's nuclear weapons program. For India, the nuclear agreement has significant strategic, political, and economic implications. India became a significant actor in the global politico-strategic paradigm by signing this agreement. India's fold gains from the pact are as follows: a) India was acknowledged in the agreement as a de facto nuclear power state, even though it had not ratified the Non-Proliferation Treaty. It amounted to an endorsement and virtual acknowledgment of India's nuclear weapons status (Chari, 2012). (b) India's strategic standing across the world was raised when it inked this agreement with the strongest country in the world. It suggested that India would be crucial to forming and maintaining the equilibrium of the new global order in the twenty-first century (Chari, 2012). (c) The agreement cleared the path for India to obtain advanced technologies without sacrificing the independence of its weapons program, ending the thirty-year nuclear trade embargo that had been placed on the country following the 1974 nuclear test. The agreement permits the recycling of wasted fuel, which is a significant issue for regenerated facilities in India. The International Atomic Energy Agency (IAEA) will inspect this as well, but not US inspectors (Chari, 2012). (d) India's military nuclear development remains unaffected by the agreement. Additionally, it gives India the chance to fortify its nuclear weapons program by constructing reactors with larger capacities and improving the accuracy with which its nuclear arsenals can be targeted. The agreement even validated India's nuclear weapons program. Additionally, the agreement gave India the chance to uphold the security of its nuclear arsenals, maintain its extraordinary record of non-proliferation, and maintain its moratorium on nuclear testing.

This agreement removes the existing prohibitions under the NSG and IAEA regulations that prevented other nuclear supplier nations from conducting nuclear business with India. By 2020, India hoped to operate 12

additional reactors, adding 1,500 tons of uranium to its annual use. Furthermore, over the next 20 years, India plans to invest between $25 billion and $50 billion in additional civilian nuclear initiatives. The mining industries in Kazakhstan, Canada, and Australia produce roughly 63% of the uranium produced worldwide. In addition to signing civil nuclear cooperation agreements with the United States, France, Russia, Kazakhstan, Namibia, Mongolia, Argentina, Canada, and Australia, India has also finalized a nuclear accord with the United States. As a result, the agreement will prove to be crucial in forging India's strategic alliance with other significant figures in global power politics. f) Regarding energy needs, it is anticipated that the agreement will alleviate India's energy scarcity, which is essential to maintaining the GDP growth rate of 8%. Owing to India's isolation from the world's nuclear commerce mainstream, the country's nuclear reactors are currently only operating at half of their installed capacity, which results in an inadequate supply of nuclear fuel (Chari, 2012). (g) The first shipments of nuclear fuel from France, Russia, and Kazakhstan reached the Rajasthan Atomic Power Station (RAPS), Rawatbhata, marking the start of the outcomes of the Indo-US nuclear agreement. 472-fuel bundles were included in the first shipment. At India's Rajasthan Atomic Power Project, the sixth nuclear reactor was completed, two months after the fifth unit, marking another significant achievement. When the sixth nuclear reactor at the RAPP began to operate, India had 22 nuclear power reactors operational, and their total generating capacity had increased to 6780 MWe. (i) India's reliance on traditional energy sources like coal, oil, and other fossil fuels will be lessened as a result. The decrease in hydrocarbons is a contentious issue that divides industrialized and developing nations (Chari, 2012). (j) Finally, from a strategic standpoint, the deal offered India tremendous worldwide clout as an ally of the United States, particularly when it came to guaranteeing India's security in a volatile neighborhood (Chari, 2012). The agreement is a big step toward India becoming more powerful and influential and playing a bigger part in both regional and global politics.

Narendra Modi- NDA-I and II (2014- Till date) – A Paradigmatic Shift.

In 2014, the BJP led NDA Government emerged victorious, and Narendra Modi became the Prime Minister**.** For him, nuclear energy constituted an important part of India's energy security. NDA government under Sh. Narendra Modi uncovered a paradigm shift in the nuclear program by announcing a policy that reflects a strong security culture. The Prime Minister continued the nuclear diplomacy that was initiated by the UPA government and signed civil nuclear deals with many countries, like the US, Japan, France, and Russia. The Indo-US bilateral relationship forged during the UPA was not destined to have smooth sailing for long, and it turned for conspicuous transformation. The passing of the Civil Liability for Nuclear Damage Act (CLND) soon became a bone of contention between the two. The civil liability regime for nuclear damage established in India has a unique provision that enables an Operator to exercise a right of recourse against a Supplier in the event of an accident (Grover, 2017). This piece of legislation incriminated suppliers of nuclear materials culpable for nuclear accidents, thus holding the US nuclear industry responsible from cradle to grave in the event of a major disaster in the future. The liability clause holding the supplier accountable appeared to be the major irritant between the two countries. The two nations attempted to restore normalcy during the first bilateral summit after Narendra Modi became Prime Minister, and as a result, a Contact Group was formed to discuss the implementation of civil nuclear energy cooperation (Einhorn and Sidhu, 2017). The Contact Group focused on India's nuclear liability law passed in 2010 which holds suppliers of nuclear equipment accountable in the event of a nuclear accident. This law also prevented US companies like Westinghouse and General Electric from investing in India's nuclear industry. Amendments to the act were not possible, so the Indian government adopted a bipartite approach.

First, it was suggested that a pool of insurance be established by the Indian Government to cover potential nuclear losses incurred by providers. Second, the Indian Government assured the United States that, in particular, article 46 of the Civil Liability Nuclear Damages Act would hold operators accountable rather than suppliers, saying that "the provisions of this Act shall be in addition to, and not in derogation of, any other law for the time being in force, and nothing contained herein shall exempt the Operator from any proceeding which might, apart from this act, be instituted against such Operator" (Haider, 2015). These doable actions assisted in breaking the standoff between the two parties. A national insurance pool of Rs 1500 crores (about US$230 million) was subsequently established by the Indian government in June 2015. India approved the Convention on Supplementary Compensation for Nuclear Damage (CSC) in February 2016, and the General Insurance Corporation of India distributed nuclear insurance coverage for the Nuclear Power Corporation of India (NPCIL), a state-owned firm that runs nuclear power reactors in India, in June 2016. The fact that Westinghouse has begun preliminary work on the construction of six nuclear power plants in India during Narendra Modi's visit to the United States in June 2016 is evidence of the effectiveness of India's strategy in settling the contentious issue of nuclear liability.

Recently, three of the four main export control regimes admitted India as a member.

In 2016, it became a member of the Missile Technology Control Regime (MTCR); in 2017, it joined the Wassenaar Arrangement; and in 2018, it joined the Australia Group (MEAI, 2018, MEAI, 2016). India has been aggressively seeking NSG membership, and many present members, including the US, Russia, Switzerland, and Japan, have expressed their open support for India's admission (Press Trust of India, 2016, IANS, 2017, Chaudhary, 2018). India has presented itself as a responsible nuclear state in its case for NSG membership, citing its solid nonproliferation record and steadfast support for total nuclear disarmament (Dasguptal, 2016)

In a 2019 agreement, the United States promised to assist India in building at least six nuclear power reactors. India's government is promoting the building of additional nuclear power facilities in an effort to boost the nation's supply of greener electricity. Aiming to more than double the number of nuclear power plants in operation in the nation, officials have made some audacious statements, proposing the construction of up to 20 additional nuclear power facilities over the course of the next ten years. A 1,400-MW project is now being built in the northern Indian state of Haryana, close to Gorakhpur village, about 90 miles northwest of New Delhi, according to announcements made by officials in February. Two 700 MW pressurized heavy-water reactors (PHWR) using Indian designs will be installed at that plant. In a 2019 agreement, the United States promised to assist India in building at least six nuclear power plants. India had placed 26 reactors under IAEA safeguards by the year 2019 (IAEA, 2018). India has inked nuclear cooperation agreements with Russia, the United States, France, the United Kingdom, South Korea, Canada, Argentina, Kazakhstan, Mongolia, Australia, Sri Lanka, Japan, Vietnam, Bangladesh, the Czech Republic, and Namibia, thanks to the NSG waiver that was granted to it in 2008. Furthermore, India has agreements with Canada, Kazakhstan, and Australia to supply uranium for its civilian nuclear reactors, and it still engages in international nuclear trading. In order to increase the amount of electricity derived from cleaner sources and help India reach its goal of having no carbon emissions by 2070, Modi plans to more than triple the country's nuclear fleet over the next ten years. In an effort to accelerate the use of nuclear energy, the nation, which now produces roughly 70% of its electricity from coal and 3% from nuclear power, has opened its atomic business to state-controlled companies other than Nuclear Power Corp. of India Ltd. Over the next ten years, Modi intends to more than triple India's nuclear fleet as the nation strives to achieve zero carbon emissions by 2070. Currently, the country generates about 70% of its electricity from coal and 3% from nuclear power. It has opened up its atomic business to state-controlled businesses other than Nuclear Power Corp. of India Ltd. in an attempt to speed up the usage of nuclear energy.

Nuclear Power Program in 2020s

Currently, the present installed nuclear power capacity in the country is 7480 MW, comprising 23 nuclear power reactors. Dr Jitendra Singh had replied in writing in Rajya Sabha that nuclear power reactors generated 46982 Million Units of electricity (including infirm generation) in 2022-23. Dr Jitendra Singh also stated that the share of nuclear power in total electricity generation in the country was about 2.8% in the year 2022-23.

Conclusion

The establishment of the Indian nuclear energy program, which serves both covert military applications and overt civilian purposes, may be attributed mostly to a favorable confluence of individuals, events, locations, global what?. The dual program has now grown to 23 grid-connected reactors with an installed capacity of 7480 megawatts electric, a record, as Dr. Jitendra Singh, MOS disclosed in a written response in the Rajya Sabha. The present installed nuclear power capacity is set to increase from 7480 MW to 22480 MW by 2031 on the progressive completion of projects under construction and accorded sanction. It is realistic to assume that by then, the vision of Bhabha of an indigenous program of nuclear power will be well on the way to being realized, notwithstanding the delays imposed by the advocates of nuclear non-proliferation. Presently, India possesses advanced capabilities in PHWR technology, positioning the nation to potentially export such reactors, particularly to developing nations seeking to establish nuclear power or research facilities. It is safe to say, however, that India would encounter significant obstacles if it attempted nuclear exports currently, considering its nuclear conflicts with the West and non-compliance with the NPT. Therefore, it is undeniably in the global interest to address these issues by fairly normalizing nuclear relationships between India and other nations worldwide.

India has approached nuclear weapons with extreme caution since 1947 due to conflicting interests and principles. Numerous of these interests and values were domestic in nature, relating to elements like self-identity, rival personalities and parties, different institutional perspectives and goals, and the country's moral mission. There was also a conflict between India's principles and goals and those of the main outside nations and the world order. Even though India had the means to acquire nuclear weapons, its leaders and people had for many years honestly expressed existential and moral concerns about doing so.

In light of the above facts and discussions, it is clear that India's nuclear program was a long-term strategy. The growth of India's nuclear arsenals and energy industry was a priority for the post-Independence leadership, first under Pt. J.L Nehru and later under his successors. While facing political divisions within India and international pressures to refrain from acquiring nuclear arsenals, successive administrations in the twenty-first century significantly influenced the country's nuclear program and resolved **nuclear ambiguity** through the adoption of distinct policies and budget allocations.

References

1. Alam MB (1988) India's Nuclear Policy. Delhi: Mittal Publications.

2. Bhabha HJ (1958) Proceedings of the Second United Nations International Conference on the Peaceful Uses of Atomic Energy. In: The Need for Atomic Energy in the Under-developed Countries, Geneva, 6 April 1958.
3. Chakma B (2005) Toward Pokhran II: Explaining India's Nuclearisation Process. 39(1). Cambridge University Press: 189–236.
4. Chari PR (2012) Indo-us Nuclear Deal Seeking Synergy in Bilateralism. New Delhi: Routledge.
5. Charnysh V (2006) A Brief History of Nuclear Proliferation. 128(11): 40–44.
6. Cohen SP (2001) India Emerging Power. Brookings Institution Press.
7. Dasgupta S (2016) China not convinced India's MTCR entry will help non-proliferation. The Times of India. 28 June.
8. Einhorn R and Sidhu WPS (2017) Operationalising US-India Civil Nuclear Cooperation. The Second Modi-Obama Summit: Building the India-US Partnership. Brookings India Initiative.
9. Grover RB (2017) The Civil Liability for Nuclear Damage Act of India: An engineering perspective regarding Supplier's liability. 101: 168–175.
10. Haider S (2015) No liability for supplier unless it is in nuclear contract: MEA. The Hindu. 9 February.
11. https://timesofindia.indiatimes.com/ (2016) China not convinced India's MTCR entry will help non-proliferation. Available at: https://timesofindia.indiatimes.com/india/China-not-convinced-Indias-MTCR-entry-will-help-non-proliferation/articleshow/52960255.cms (accessed 26 March 2024).
12. IAEA (2009) Agreement Between the Government of India and the International Atomic Energy Agency for the Application of Safeguards to Civilian Nuclear Facilities. Available at: https://www.iaea.org/publications/documents/infcircs/agreement-between-government-india-and-international-atomic-energy-agency-application-safeguards-civilian-nuclear-facilities (accessed 26 March 2024).
13. Kapur A (2001) Pokhran and Beyond: India's Nuclear Behaviour. New Delhi: Oxford University Press.
14. Karnad B (2008) India's Nuclear Policy. Bloomsbury Academic.
15. Perkovich G (1999) India's Nuclear Bomb : The Impact of Global Proliferation. University of California Press.
16. Raja R (2016) India's Quest for Power and Status: A Study of India's Nuclear Policy. 21(9): 1–10.
17. Roy Choudhary D (2018) Trying to get support of other nations for India's NSG bid: Japan. The Economic Times. 12 July.
18. Salik N (2009) The Genesis of South Asian Nuclear Deterrence: Pakistan's Perspective. Karachi: Oxford University Press.
19. Sharma D (1986) The Indian Atom: Power & Proliferation: A Documentary History of Nuclear Policies, Development, and the Critics, 1958-1986. Philosophy and Social Action.
20. The Economic Times (2018) Donald Trump administration urges NSG members to support India's application. Available at: https://economictimes.indiatimes.com/news/defence/donald-trump-administration-urges-nsg-members-to-support-indias-application/articleshow/59796299.cms (accessed 16 March 2024).
21. www.mea.gov.in (2016) India Joins Missile Technology Control Regime. Available at: https://www.mea.gov.in/press-releases.htm?dtl/26953 (accessed 23 February 2024).
22. www.mea.gov.in (2017) India joins the Wassenaar Arrangement. Available at: https://www.mea.gov.in/press-releases.htm?dtl/29164/India_Joins_the_Wassenaar_Arrangement (accessed 25 March 2024).
23. www.mea.gov.in (2018) Press Release: India Joins The Australia Group. Available at: https://www.dfat.gov.au/publications/minisite/theaustraliagroupnet/site/en/india_statement.html (accessed 26 March 2024).

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