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STRUCTURAL CHANGES IN SINO-RUSSIAN ENERGY COOPERATION

Lyu Lingli ✉ , **L.A. Guzikova**

Peter the Great St. Petersburg Polytechnic University,
St. Petersburg, Russian Federation

✉ Lyu13659367601@outlook.com

Abstract. Intensification of geopolitical instability has fundamentally reconfigured the structural foundations of Sino-Russian energy cooperation. Confronted with unprecedented Western financial sanctions and supply chain disruptions, bilateral cooperation has undergone a fundamental transition from simple quantitative expansion toward building institutional resilience. Through a comprehensive analysis of empirical data, including trade dynamics and joint project structures, this study reveals a system of three complementary and synergistic mechanisms underpinning this structural transformation: 1) strategic reconfiguration of infrastructure; 2) innovative instrumentalization of settlement mechanisms; 3) institutionalized integration based on equity participation. The development of pipeline networks, such as the Power of Siberia, and Arctic liquefied natural gas (LNG) projects has not only diversified supply sources but also driven a strategic redistribution of global energy flows, effectively mitigating geopolitical risks associated with traditional transit routes. The Renminbi payment system has evolved from a crisis-response tool into a complete, institutionalized financial infrastructure; its share in energy settlements has grown, effectively hedging sanction risks and systematically reducing reliance on the US dollar system. In strategic projects like Yamal LNG and Arctic LNG 2, the Chinese side, through tiered equity participation models, has secured shared governance and internalized risks, elevating the level of cooperation from transactional relationships to strategic co-management. The research demonstrates that these interlocking mechanisms successfully convert external pressure into internal structural resilience, collectively establishing an independent Arctic–Northeast Asia energy corridor. This study provides a replicable analytical model and practical paradigm for emerging economies confronting geopolitical fragmentation, illustrating how infrastructure sovereignty, currency instrumentalization and co-governance architectures offer a viable alternative pathway for constructing a more resilient energy security system independent of US dollar hegemony. The findings are of interest to corporate executives involved in China–Russia energy cooperation and to academic researchers studying international energy cooperation within a shifting geopolitical landscape.

Keywords: geopolitical instability, Sino-Russian energy cooperation, infrastructure development, settlement mechanisms, equity cooperation

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СТРУКТУРНЫЕ ИЗМЕНЕНИЯ В КИТАЙСКО-РОССИЙСКОМ ЭНЕРГЕТИЧЕСКОМ СОТРУДНИЧЕСТВЕ

Люй Линли ✉ , **Л.А. Гузикова**

Санкт-Петербургский политехнический университет Петра Великого,
Санкт-Петербург, Российская Федерация

✉ Lyu13659367601@outlook.com

Аннотация. Усиление геополитической нестабильности фундаментально перестроило структурные основы китайско-российского энергетического сотрудничества. Перед лицом беспрецедентных западных финансовых санкций и сбоев в цепочках поставок двустороннее сотрудничество осуществило фундаментальный переход от простого экстенсивного расширения к построению институциональной устойчивости. На основе комплексного анализа эмпирических данных, включая динамику торговли и структуры совместных проектов, в данном исследовании раскрывается система трех взаимодополняющих и синергетических механизмов, лежащих в основе этой структурной трансформации: 1) стратегической реконфигурации инфраструктуры; 2) инновационной инструментализации расчетных механизмов; 3) институциональной интеграции на основе долевого участия. Создание трубопроводных сетей, таких как «Сила Сибири», и реализация арктических проектов по сжиженному природному газу (СПГ) не только диверсифицировали источники поставок, но и привели к стратегическому перераспределению глобальных энергетических потоков, эффективно минимизируя геополитические риски традиционных маршрутов. Платежная система в юанях эволюционировала из инструмента реагирования на кризис в полноценную институциональную финансовую инфраструктуру; ее доля в расчетах за энергоносители возросла, что позволило эффективно хеджировать санкционные риски и системно снизить зависимость от долларовой системы. В стратегических проектах, таких как «Ямал СПГ» и «Арктик СПГ 2», китайская сторона через модели ступенчатого долевого участия обеспечила совместное управление и интернализацию рисков, подняв уровень сотрудничества с транзакционного до уровня стратегического соуправления. Исследование показывает, что эти взаимосвязанные механизмы успешно преобразуют внешнее давление во внутреннюю структурную устойчивость, совместно формируя независимый энергетический коридор «Арктика – Северо-Восточная Азия». Данное исследование предлагает воспроизводимую аналитическую модель и практическую парадигму для стран с формирующимся рынком, сталкивающихся с геополитической фрагментацией, наглядно демонстрируя, как инфраструктурный суверенитет, инструментализация валюты и архитектура совместного управления открывают жизнеспособный альтернативный путь для построения более устойчивой системы энергетической безопасности, независимой от гегемонии доллара США. Полученные результаты представляют интерес для руководителей компаний, участвующих в энергетическом сотрудничестве Китая и России и для академических исследователей, изучающих вопросы международного энергетического сотрудничества в меняющейся геополитической обстановке.

Ключевые слова: геополитическая нестабильность, китайско-российское энергетическое сотрудничество, развитие инфраструктуры, расчетные механизмы, долевое сотрудничество

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Introduction

Energy cooperation and interaction are closely linked to the geopolitical interests of major energy powers and current international events. The escalation of the Russia–Ukraine conflict in 2022 triggered unprecedented financial and technological sanctions by Western countries against Russia, leading to structural disruptions in the global energy trading system [1]. The resulting sharp contraction of the European market forced Russia to strategically reorient its energy exports "eastward", making Sino-Russian energy cooperation a key variable in the ongoing geopolitical restructuring [2, 3]. Against this backdrop, bilateral energy trade not only remained unimpeded but achieved significant counter-trend expansion [4, 5]. In 2024, China's crude oil imports from Russia reached 108 million tons, a year-on-year increase of 19.6%; pipeline natural gas deliveries amounted to 31 billion m^3; and liquefied natural gas (LNG) imports climbed to 8.6 million tons – all reaching historic highs [6]. This growth momentum indicates that bilateral cooperation has moved beyond simple quantitative expansion and is undergoing a profound structural transformation. This transformation benefits not only from the resilience of key infrastructure projects such as the Power of Siberia pipeline and the Yamal LNG project but also directly stems from the application of innovative mechanisms such as Renminbi (RMB) settlement [7, 8].

The object of this study is the mechanisms underlying the structural transformation of Sino-Russian energy cooperation against the backdrop of geopolitical crisis. The research focuses on three synergistic mechanisms that form the basis of this transformation: infrastructure restructuring, settlement mechanism innovation and equity-based institutional integration. The main purpose of this study is to systematically reveal how the above-mentioned mechanisms jointly build the structural resilience of Sino-Russian energy cooperation. To achieve this purpose, the following tasks are set:

- to clarify the phased evolution of the "sanctions discount" mechanism in crude oil trade and the changing dynamics of its arbitrage space;
- to analyze how the infrastructure expansion of pipeline natural gas and Arctic LNG projects drives the strategic realignment of energy flows;
- to evaluate the evolution of the RMB settlement mechanism from a crisis-response tool into an institutionalized financial infrastructure and to assess its role;
- to elucidate the transformation in governance models achieved through specific equity structures in Arctic energy projects;
- to comprehensively demonstrate how the synergy of these three mechanisms converts external geopolitical pressure into internal structural resilience.

Literature review

The geopolitical crisis emanating from the Russia–Ukraine conflict has been identified in academic literature as a catalyst for profound global realignments [9, 10]. Research indicates that such crises not only trigger a restructuring of global energy supply routes [11] but also exert far-reaching impacts on the world economy [12] and expose vulnerabilities within global energy supply chains [13]. More profoundly, this episode has starkly illuminated the complex and interdependent relationship between geopolitics, geo-economics and energy resource distribution [14]. The stringent sanctions regime imposed by Western nations serves as a prime example [15], directly causing a precipitous decline in Russia's LNG exports to Europe while simultaneously accelerating its strategic pivot towards Asian markets [16, 17]. This empirical observation aligns with the theoretical arguments of scholars [16, 18], who posit that the Russia–Ukraine crisis is, at its core, a manifestation of the intricate interplay between established energy trade patterns and geopolitical maneuvering [18]. Furthermore, fundamental imbalances in energy supply and demand are themselves recognized as a potent source of geopolitical risk [19].

Regarding the socio-economic consequences of such conflicts, a consensus exists within the literature that geopolitical strife transmits devastating geo-economic shocks through multiple channels, including significant social welfare losses [20, 21], spikes in global commodity prices [22, 23] and pervasive inflationary pressures [24].

The theoretical underpinnings of this study are partially rooted in Transaction Cost Economics (TCE), which provides a framework for understanding how firms and states mitigate institutional uncertainty. TCE suggests that the hazards arising from sanctions can be alleviated through long-term contracts, which lock in prices and volumes via credible commitments to reduce opportunism, and through equity-based collaborations, which internalize risks by sharing residual control rights [25]. This theoretical lens is clearly reflected in the Sino-Russian context, where the deepening of long-term partnerships in energy has been institutionalized through equity cooperation in major projects like Yamal LNG, Arctic LNG 2 and the Rajin Port logistics hub, significantly enhancing supply stability.

Concurrently, the financial dimension of energy trade has undergone a pivotal transformation. The move towards dedollarization, with over 40 countries exploring cross-border local currency settlement, finds a critical testing ground in Sino-Russian energy trade [26]. From the perspective of energy financialization, the rising share of RMB settlement is not merely a technical shift but a strategic extension of institutional power through the pursuit of pricing influence [27]. A stable RMB exchange rate enhances its attractiveness as a reliable invoicing currency, gradually eroding the financial risks associated with a dollar-dominated system.

Lastly, the physical infrastructure of energy trade is itself a subject of geopolitical analysis [28]. Scholars [27] argue that pipeline networks are tangible embodiments of geopolitical power, essentially representing an extension of territorial control [29]. The strategic preference for "direct connection" pipelines that bypass transit countries underscores how infrastructure is leveraged as a tool to consolidate supplier dominance and mitigate third-party political risks [30], a dynamic clearly evident in the negotiations over the proposed Power of Siberia 2 pipeline's route.

By integrating insights from these diverse yet interconnected strands of literature – covering the geopolitical economy of conflict, the theory of institutional risk management, the financialization of energy and the geopolitics of infrastructure – this review establishes a comprehensive framework for analyzing the tripartite synergistic mechanisms (infrastructure, settlement, equity) driving the structural evolution of Sino-Russian energy cooperation.

Methods and materials

This study adopts empirical research, integrating quantitative trend analysis, typical case studies and mechanism analysis. By examining data on the scale, pricing and structure of Sino-Russian energy cooperation from 2020 to 2024, it reveals evolutionary trends. Key projects such as Power of Siberia pipeline and Yamal LNG are selected for in-depth case analysis to illustrate the transformation of cooperation models. Within a theoretical framework, the study systematically analyzes the synergistic mechanisms among infrastructure, settlement mechanisms and equity governance to demonstrate the pathway for building structural resilience.

The materials and data used in this analysis are primarily sourced from the following channels: energy trade data are obtained from the International Energy Agency (IEA)[1], National Bureau of Statistics of China[2] and the General Administration of Customs of the People's Republic of China[3]; data and policy references related to RMB settlement are derived from the People's Bank of China[4], the State Administration of Foreign Exchange[5] and publicly available research reports; information on the equity structures and agreement terms of specific cooperation projects is drawn from the annual reports of PAO Novatek, publicly disclosed documents of Chinese participating enterprises, as well as project agreements and announcements officially released by China and Russia.

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Results and discussion

Restructuring of energy trade scale

Crude oil: The phased evolution of the sanctions discount mechanism

Between 2020 and 2024, Russia's crude oil imports to China overall showed an upward trend with an average annual growth rate of 6.9%, except for a temporary decline in 2021 due to OPEC+ production cuts. This reflects China's forward-looking strategy in strategic energy reserves (Table 1).

Table 1. Evolution of import volume and price mechanism of crude oil from Russia to China, 2020–2024

Year	Import Volume (MT)	Import Value (USD Billion)	Unit Price (USD/bbl)	Premium/(Discount) vs Brent
2020	83.44	27.69	45.27	+3.31
2021	79.64	40.54	69.44	–1.42
2022	86.24	58.58	92.68	–6.36
2023	107.02	60.70	77.38	–5.30
2024	108.47	62.59	78.72	–4.78

Source: International Energy Agency, National Bureau of Statistics, General Administration of Customs

The evolution of the pricing mechanism exhibits a three-phase characteristic.

The first phase occurred during the pandemic period (2020–2021). In 2020, the average Brent crude price was USD 41.96 per barrel, while the average landed price of Russian oil in China was USD 45.27 per barrel, representing a premium of USD 3.31 over Brent. This was primarily driven by reliance on established transportation routes and infrastructure rigidity. In 2021, influenced by OPEC+ production cuts and adjustments to long-term contract pricing terms, the price differential shifted from a premium to a discount, narrowing to USD 1.42 (meaning Russian oil was priced USD 1.42 per barrel below Brent).

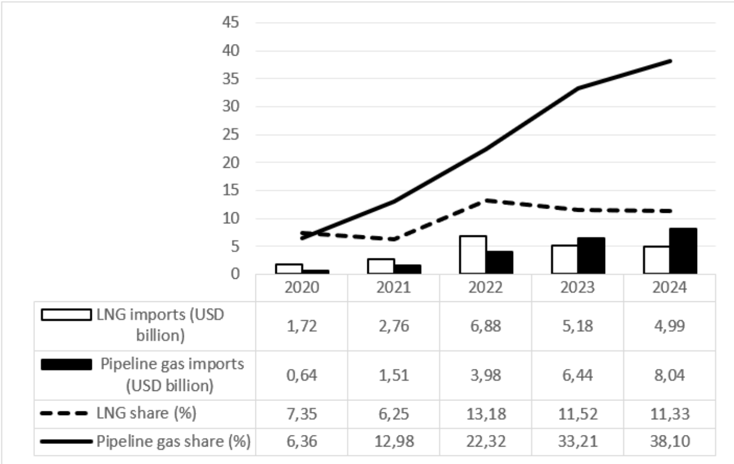
The second phase was the sanctions premium period (2022). The average price of Russian oil reached USD 92.68 per barrel, at a discount of USD 6.36 to Brent. This was mainly due to freight premiums from the "shadow fleet", costs related to insurance and compliance risks, and frictions in the payment system.

The third phase marks the price cap era (2023–2024). In 2023, the G7 implemented a price cap policy on Russian oil, causing the free on board (FOB) price of Russian oil to fall to USD 62.59 per barrel. The landed price in China was USD 77.38 per barrel, still enjoying a discount of USD 5.30. By 2024, this discount further narrowed to USD 4.78, primarily because expanded re-export trade from India diluted bargaining leverage. During this phase, long-term contracts transformed sanctions risk into a tool for discount arbitrage, but the expansion of third-party evasion mechanisms is gradually compressing arbitrage opportunities.

Natural gas: Infrastructure-driven transformation of the supply structure

Between 2020 and 2024, the share of pipeline gas imports from Russia to China surged from 6.36% to 38.1% (calculated based on data under HS code 271121 from the General Administration of Customs), making Russia China's largest pipeline natural gas supplier, replacing Turkmenistan. This structural shift was primarily driven by the systemic expansion and strategic reconfiguration of infrastructure capacity (Fig. 1).

As of 2024, the cumulative gas transmission volume of the Power of Siberia pipeline has reached 82 billion m^3. The "Eastern Redirection" initiative launched in 2022 enabled it to absorb a redirected volume of 65 billion m^3 per year originally destined for Europe. At the same time, the Far Eastern



Source: National Bureau of Statistics, General Administration of Customs

Fig. 1. Evolution of China's natural gas import structure from Russia, 2020–2024

Pipeline project is scheduled for completion in 2026, which will secure a stable gas supply of 10 billion m^3 per year from Sakhalin, reshape Northeast Asia's energy supply landscape and establish a multi-source supply corridor linking the Arctic and Northeast Asia. On the Sino-Mongolian border, the Power of Siberia 2 project has encountered delays due to disagreements over transit fees through Mongolian territory. China insists on a direct connection route, reflecting a strategic trade-off between infrastructure control and geopolitical risk management (Table 2).

Table 2. China-Russia key natural gas pipeline infrastructure indicators and strategic functions, 2024

Pipeline Name	Key Metrics	Strategic Significance
Power of Siberia	Cumulative transmission: 82 billion m^3 (2024)	Significantly increased the proportion of pipeline gas imported from Russia to China over a five-year period
Far Eastern Pipeline (under construction)	To secure gas supply of 10 billion m^3/year from Sakhalin (2026)	Reshape Northeast Asia's energy supply landscape and establish a diversified Arctic–Northeast Asia supply corridor
Power of Siberia 2	Heightened geopolitical risks in the Mongolian section	China's insistence on a direct connection underscores its strategic emphasis on infrastructure control and avoiding potential third-party interference

Source: International Energy Agency, General Administration of Customs, Ministry of Energy of Russia

In terms of LNG (Fig. 1), the proportion of China's imports from Russia in 2024 accounted for 11.33%, with a growth rate significantly lower than that of pipeline gas. The primary reason is that the tiered pricing clauses for pipeline gas have locked in long-term prices notably lower than spot prices, thereby suppressing the price premium for LNG. Arctic projects, meanwhile, exhibit a dual effect: the Yamal LNG project, through China's 29.9% equity stake, secures a long-term supply guarantee of 6 million tons per year, whereas the Arctic LNG 2 project has faced a construction delay of up to two years due to embargoes on critical modules by Europe and the United States.

Coal: Diminishing marginal returns from sanction-driven gains and structural bottlenecks

In 2022, following the European ban on Russian coal, China's coal imports from Russia surged to 67.32 million tons, a year-on-year increase of 26%. In 2023, the share of Russian coal in China's total coal import value rose to 26.5%, with volume reaching 78.92 million tons. However, imports declined to 62.18 million tons in 2024, reflecting a trend of diminishing marginal returns from sanction-driven gains (Table 3).

Table 3. Scale and structural changes in China's coal imports from Russia, 2020–2024

Year	Import Volume (million tons)	Import Value (billion USD)	Average Price (USD/ton)	Share of China's Total Import Value
2020	3955	3.47	50.1	18.2%
2021	5346	7.83	146.5	23.6%
2022	6732	14.92	221.6	28.9%
2023	7892	13.15	166.7	26.5%
2024	6218	10.35	116.4	20.1%

Source: National Bureau of Statistics, General Administration of Customs

This decline is driven by three structural bottlenecks. First, logistical capacity has peaked: in 2023, the annual handling capacity of Russia's Far Eastern ports reached 110 million tons, with a utilization rate as high as 98%, while competition from countries such as India further pushed up shipping costs. Second, the quality disadvantage of Russian coal has become increasingly evident – its average sulfur content is higher than that of mainstream Australian coal, raising end-user desulfurization costs. Finally, although the FOB price of Russian coal has declined, dropping from USD 82 per ton at Ust-Luga in 2022 to USD 65 per ton in 2024, the comprehensive landed cost under sanctions remains high. The landed cost in China still reached USD 110.9 per ton, eroding its price advantage.

Instrumental role of settlement mechanisms

The profound transformation in the scale and structure of China–Russia energy trade has been critically supported by the innovation and instrumental application of settlement mechanisms. Faced with a complex geopolitical environment and pressure from Western financial sanctions, the restructuring of the settlement system has not merely involved technical changes in payment methods – it has served as a strategic tool to convert potential trade obstacles into structural resilience in cooperation, thereby directly enhancing the security and stability of energy supply.

The evolution of settlement mechanisms has exhibited clear phased leaps, closely aligning with and supporting the expansion and structural optimization of energy trade.

In the initial phase (2020–2021), building on the signing of a bilateral local currency settlement framework agreement, innovation in settlements primarily focused on pilot programs for specific categories such as natural gas. The expansion of the Cross-Border Interbank Payment System (CIPS) and upgrades to bilateral settlement systems laid the foundation for further deepening. The share of RMB settlement rose to 15–20%, covering key categories including crude oil and coal, preliminarily reducing reliance on the US dollar (Table 4).

The critical turning point occurred in 2022, when the expulsion of major Russian banks from the SWIFT system, a major geopolitical shock, forced an accelerated transformation of settlement mechanisms, underscoring their instrumental role as never before. The proportion of RMB settlement in energy trade surged sharply to 60–70%, becoming the core payment method particularly in coal trade affected by European sanctions and in rapidly growing pipeline natural gas trade. This effectively mitigated the risk of payment channel disruptions and ensured the continuity of trade flows (Table 4).

In the deepening and institutionalization phase (2023–2024), settlement mechanisms further matured and expanded to cover all energy categories. Russia's National Wealth Fund significantly increased the share of RMB assets to 60%, providing deep monetary and credit support for energy trade. The share of RMB settlement stabilized at over 85%, covering crude oil, LNG, electric power and even new pipeline projects. A landmark development was the preparation for the establishment of a China–Russia energy exchange, marking the transformation of the RMB pricing and settlement mechanism from an emergency tool into an institutionalized, market-oriented core infrastructure. This provides a predictable financial environment with reduced political interference for long-term energy cooperation (Table 4).

Table 4. Phased evolution of RMB settlement in China–Russia energy trade, 2020–2024

Year	Share of RMB Settlement (Energy)	Major Categories	Milestone Events & Key Drivers
2020	<10%	Pilot natural gas trade	Signing of the Sino-Russian local currency settlement framework agreement
2021	15–20%	Crude oil, coal	Expansion of the CIPS; upgrade of bilateral settlement systems
2022	60–70%	Coal, pipeline natural gas	Expulsion of Russian banks from SWIFT; accelerated RMB adoption (geopolitically driven)
2023	80–90%	Crude oil, LNG, electric power	Russian National Wealth Fund increased RMB assets to 60%
2024	>85%	All categories (including new pipelines)	Preparation for China–Russia Energy Exchange; institutionalization of RMB pricing mechanisms

Source: People's Bank of China, General Administration of Customs, State Administration of Foreign Exchange

In summary, the innovation and application of the RMB settlement mechanism have evolved beyond a mere payment function into a crucial strategic stabilizer and risk transformer within the structural reshaping of China–Russia energy trade. It has effectively hedged against external sanctions, reduced transaction costs and uncertainties, and ultimately internalized as a core institutional force driving the bilateral energy relationship toward a more independent, closely integrated and resilient architecture – profoundly shaping the financial foundation of the Arctic–Northeast Asia energy corridor.

It should be emphasized, however, that while the settlement mechanism primarily mitigates payment disruption risks, it cannot fully absorb volatility in trade volumes resulting from physical bottlenecks.

Future trends: From reactive cooperation to institutional integration

The structural transformation of China–Russia energy trade is entering a new phase characterized by deep institutional integration. Building on the supply foundation established through scale reconfiguration and the financial support provided by settlement mechanisms, future cooperation will extend beyond short-term sanction responses toward systematic institutional development, which is primarily reflected in three strategic directions:

1–2) Pipeline Expansion and Route Diversification, building a networked infrastructure system.

In the short term, efforts will prioritize enhancing the gas transmission capacity of the Power of Siberia pipeline to accelerate the filling of the supply gap left by the exit from the European market. In the long term, a three-pronged approach will reconfigure energy flows between Asia and Europe: the Arctic route will rely on Yamal LNG and Arctic LNG 2 to boost liquefied natural gas transmission capacity and overcome delays caused by Western technology embargoes; the Far East will see the development of integrated land-sea synergy, with the Far Eastern Pipeline, scheduled for operation in

2026, securing natural gas supply from Sakhalin and forming a dual-channel system of “pipeline gas + LNG transshipment” together with the Rason Port Hub to weaken Japan’s regional pricing power; and the direct-connect option for the Power of Siberia 2 pipeline, if implemented, would circumvent third-country risks, though it requires balancing Mongolia’s transit fee demands with the pipeline’s economic viability.

3) Equity cooperation as an institutionalized risk-sharing framework.

Equity cooperation (Table 5) has evolved into an institutionalized structure for risk sharing. In the Yamal LNG project, China’s 29.9% stake (comprising CNPC’s 20% and the Silk Road Fund’s 9.9%) secures priority access to 6 million tons of LNG per year, directly hedging the financing gap risk caused by Total’s exit. For Arctic LNG 2, the 10% holdings each by two Chinese state-owned enterprises grant, under Article 49 of the Russian Federal Law on Joint-Stock Companies, the ability to veto special resolutions – as major decisions require more than 75% approval – providing China with substantial influence through its collective 20% stake. A 49% share in the Rason Port Hub ensures operational control and mitigates asset risks stemming from political volatility in North Korea. This tiered equity structure – 29.9%, 20% and 49% – signals a structural shift in China–Russia energy cooperation from mere capital investment to shared governance.

Table 5. Equity cooperation structure in China–Russia Arctic energy projects

Project Name	Location	Chinese Participants	Russian Participant	Chinese Stake	Russian Stake	Risk Challenges
Yamal LNG	Yamal Peninsula	CNPC, Silk Road Fund	Novatek	20%, 9.9%	50.1%	Financing gap due to Total's exit
Arctic LNG 2	Gydan Peninsula	CNPC, CNOOC	Novatek	10%, 10%	70%	Construction delays from Western equipment embargo
Rason Port Logistics Hub	Rason, DPRK	COSCO	Zarubezhneft	49%	51%	Investment uncertainty due to DPRK political volatility

Source: Novatek Annual Report (2023), Ministry of Commerce of China Overseas Investment Bulletin

The endogenous deepening of the RMB mechanism has coupled finance with trade. The settlement tool will further transform into institutional power, extending to pricing influence. The under-construction China–Russia Energy Exchange will expand RMB denomination from trade settlement to the futures market, promoting regional pricing diversification. The linkage between tiered pricing for pipeline gas and long-term RMB-denominated gas purchase agreements creates a dual guarantee of “physical supply + financial stability”, narrowing opportunities for third-party arbitrage.

Conclusion

This study, based on an empirical analysis of the scale, structure, settlement mechanisms and cooperation models of Sino-Russian energy trade from 2020 to 2024, yields the following results:

1) Substantial transformation of the trade structure. Russia has become China’s largest supplier of pipeline natural gas, crude oil imports reached a historic high in 2024, while coal imports exhibit a trend of diminishing sanctions-related gains.

2) Three-phase evolution of the crude oil pricing mechanism. The pricing shifted from an initial premium (2020) to a sanctions discount (2022), and subsequently maintained a stable discount during the price cap period, although third-party re-export trade is compressing the arbitrage space for direct trade.

3) Infrastructure-driven formation of a new supply corridor. The Power of Siberia pipeline and Arctic LNG projects have jointly established the Arctic–Northeast Asia energy corridor, although negotiations for new pipelines and project construction continue to face geopolitical and technical support challenges.

4) Institutionalized transformation of RMB settlement. The proportion of RMB settlement in creased from less than 10% to over 85%, marked by the establishment of an energy exchange, transitioning it from an emergency tool to an institutionalized financial infrastructure.

5) Upgrade in governance model through equity cooperation. Through a tiered equity structure, China has achieved a shift from capital investment to risk-sharing and joint governance in key projects.

Based on the above results, this study forms the following conclusions:

1. Sino-Russian energy cooperation has established a three-dimensional synergistic system comprising infrastructure, settlement mechanisms and equity governance. This system constitutes the core mechanism for resisting geopolitical risks and achieving structural transformation.

2. Facing external sanctions pressure, bilateral cooperation has demonstrated significant adaptability. It can convert short-term market risks into trade momentum and systematically construct alternative logistical and financial channels to circumvent long-term systemic risks.

3. The depth of energy cooperation has evolved from a traditional trade-investment relationship to a deeply integrated strategic co-governance relationship. The equity structure has become a key institutional arrangement for locking in long-term interests and achieving risk internalization.

Future research directions

1. Track the dynamic interplay between the sanctions discount mechanism and third-party re-export channels, quantifying the evolution of arbitrage opportunities.

2. Assess the impact of ongoing energy infrastructure projects on the stability and economic viability of the Arctic–Northeast Asia corridor.

3. Analyze the obstacles and effectiveness of expanding the RMB settlement mechanism into derivatives pricing and project financing.

4. Investigate the effectiveness of the equity-based co-governance model in ensuring project operations and asset preservation under extreme scenarios.

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INFORMATION ABOUT AUTHORS / СВЕДЕНИЯ ОБ АВТОРАХ

ЛЮЙ Линли
E-mail: Lyu13659367601@outlook.com
LYU Lingli
E-mail: Lyu13659367601@outlook.com
ORCID: https://orcid.org/0009-0007-8021-6168

ГУЗИКОВА Людмила Александровна
E-mail: guzikova@mail.ru
Liudmila A. GUZIKOVA
E-mail: guzikova@mail.ru

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