



Bridging the Green Gap:

Green Finance as a Catalyst for the Green Transition

CTTN Research Grants Program 2025

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Executive Summary

This report examines the growing importance of green finance as a catalyst for the green transition in the Central Asia Regional Economic Cooperation (CAREC) countries, where economic development has traditionally relied on fossil fuels and carbon-intensive infrastructure. It highlights the increasing urgency of shifting toward low-carbon, climate-resilient development amid rising climate risks, energy insecurity, and global decarbonization commitments. The report identifies significant disparities in green finance readiness and implementation across the region. Countries such as Kazakhstan, Uzbekistan, and China have made notable progress in establishing green bond markets, renewable energy targets, and national taxonomies, whereas others, including Afghanistan, Turkmenistan, and Tajikistan continue to face institutional, regulatory, and financial constraints. Using an entropy-based index, the report quantitatively assesses each country's performance in mobilizing and deploying green finance. It finds that while external funding from Multilateral Development Banks—such as the Asian Development Bank, European Bank for Reconstruction and Development, and Islamic Development Bank—has played a vital role through concessional loans, blended finance, and capacity-building initiatives, the overall scale of investment remains insufficient relative to regional needs, which are estimated to exceed USD 400 billion by 2030. The report also emphasizes the importance of Public-Private Partnerships in delivering green infrastructure. Successful examples in Uzbekistan and Azerbaijan demonstrate how transparent tendering processes, de-risking instruments, and international support can attract private investment in clean energy and sustainable transport. Policy recommendations include developing clear national green finance strategies, expanding green taxonomies, strengthening domestic capital markets, and enhancing regional cooperation platforms such as the CAREC Green Energy Alliance. Together, these measures are essential for bridging the green finance gap and ensuring an inclusive, just, and sustainable transition across the CAREC region.

1. Introduction

1.1 Background and objective

Over the past few decades, the world has witnessed unprecedented economic growth, with global GDP almost tripling since 1990 (World Bank, 2023). However, this rapid economic development has come at the cost of environmental degradation and resource exhaustion. For example, since the 1990s, global carbon dioxide (CO₂) emissions from fossil fuel combustion have increased from 21,328 million tons in 1990 to 37,400 million tons in 2024 (IEA, 2025). This trend has led to severe consequences, including global warming, more frequent extreme weather events, and ecological imbalance.

Currently, the global economic development model remains highly reliant on a high-carbon energy systems, with a significant positive correlation between economic growth and carbon emissions. Although some developed countries have achieved partial decoupling through technological upgrading and industrial transformation, developing countries—constrained by their stage of industrialization and growing energy demand—continue to experience sustained increases in total carbon emissions.

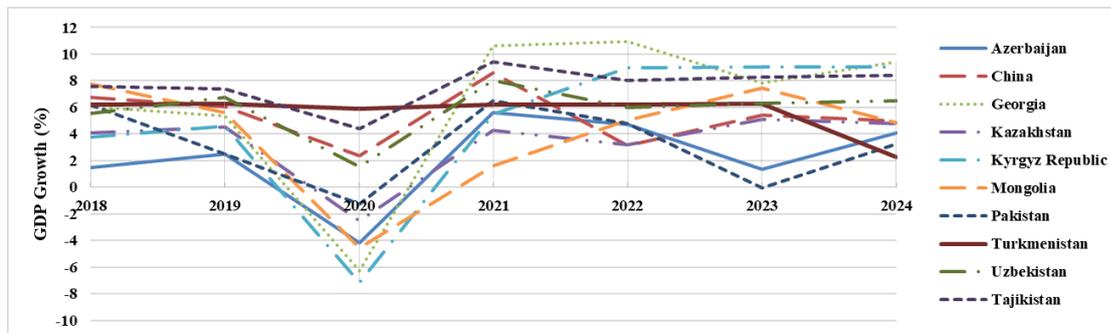
The international community has reached broad consensus on the need to balance economic growth with emission reduction goals. However, significant differences remain in terms of specific implementation pathways. Developed countries generally advocate promoting global emission reduction through technology transfer and financial support, while developing countries emphasize the principle of "common but differentiated responsibilities" and call for fairer mechanisms for allocating carbon emission rights.

As emerging economies, the countries participating in the Central Asia Regional Economic Cooperation (CAREC) program—including Kazakhstan, Uzbekistan, Azerbaijan, and others—have achieved relatively stable GDP growth over the past few decades (see Figure 1.1). However, due to their high dependence on fossil fuels, low energy system efficiency, and aging industrial infrastructure, these countries generally exhibit high carbon emission intensity, with CO₂ emissions per unit of GDP ranking among the highest globally.

While maintaining economic growth, CAREC member states face an urgent need to promote low-carbon transformation to address global climate challenges. By optimizing energy structures, upgrading industrial technologies, and strengthening policy frameworks, these

countries can pursue sustainable development while reducing carbon emissions. Looking ahead, strengthening regional cooperation and learning from international experiences will be important drivers of low-carbon development in the CAREC region.

Figure 1.1 GDP Growth (%) of CAREC Countries



Data Source: World Bank, World Development Indicators. <https://databank.worldbank.org/source/world-development-indicators#>

To address global climate change, the transition to a low-carbon and environmentally sustainable economy (i.e., the green transition) has become an inevitable global trend. However, the current green transition process still faces numerous structural obstacles that urgently require systemic reforms and resource inputs. In practice, the green transition involves fundamental transformations in key sectors such as energy, industry, transportation, and agriculture. Its core objectives include reducing greenhouse gas emissions, improving resource-use efficiency, and promoting the adoption of renewable energy.

Technological upgrading and infrastructure modernization across these sectors require substantial financial support. For example, to accommodate the grid-integration needs of variable renewable energy sources such as solar and wind power, traditional electricity grids must undergo large-scale modernization, requiring billions of dollars in investment. Similarly, industrial decarbonization, electrification of public transportation, and energy-efficient building retrofits require long-term and stable financing. According to the International Energy Agency (IEA, 2021), achieving net-zero emissions by 2050 will require global annual investment in clean energy to increase from USD 1.2 trillion in 2020 to more than USD 4 trillion in 2030.

However, CAREC member countries are constrained by limited fiscal capacity and underdeveloped green capital markets, making it difficult to mobilize such large-scale funding.

Without targeted green financial instruments, the green transition in the CAREC region may fall short of national commitments and international climate goals.

In the context of the global green transition, establishing sound green financial mechanisms is essential for CAREC countries to achieve sustainable development. Green finance was originally defined by the United Nations Environment Programme Finance Initiative (UNEP FI, 2016) as financial investments directed toward sustainable development projects and initiatives. In recent years, scholars have expanded this definition to encompass a range of financial instruments, institutional mechanisms, and policy frameworks that allocate capital to activities with measurable environmental benefits, such as emission reduction, energy efficiency improvement, and biodiversity protection (Zhang et al., 2022a).

Key green finance instruments include environmental, social, and governance (ESG) investment frameworks, sustainability-linked loans, green bonds, climate funds, and green credit. Previous studies have also emphasized the role of green finance in addressing funding gaps for green technologies, internalizing environmental risks, and guiding capital flows toward development pathways consistent with climate mitigation objectives (Campiglio, 2016; Chenet et al., 2021).

However, shaped by long-standing traditional development models and policy frameworks, the design and implementation of green finance systems in CAREC countries exhibit structural weaknesses that are inconsistent with sustainable development goals. Policy fragmentation remains a major challenge, with many governments introducing isolated measures in specific areas (e.g., renewable energy) without establishing comprehensive frameworks covering environmental risk assessment, information disclosure, and incentive mechanisms. The lack of coherent top-level design has limited policy coordination and reduced overall effectiveness.

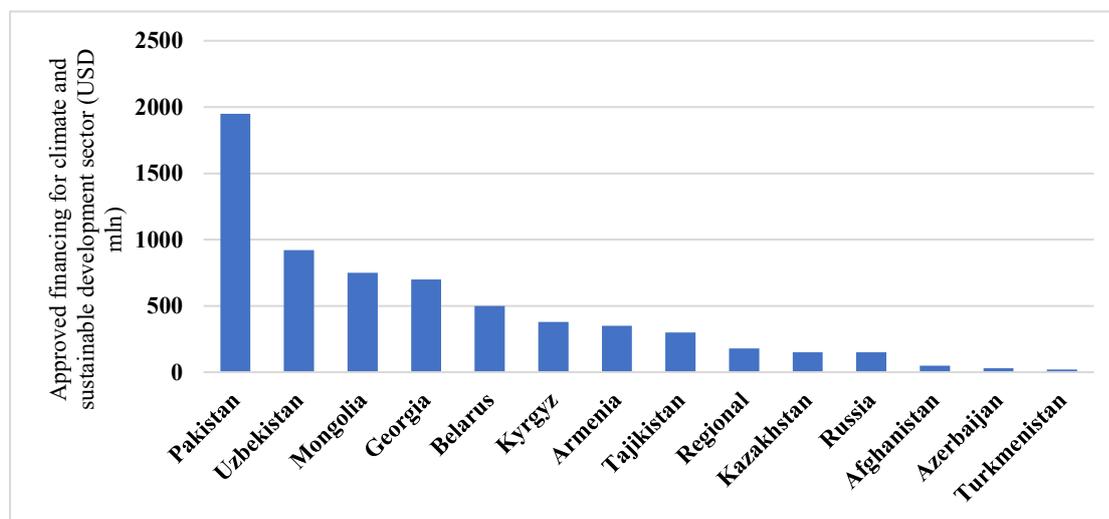
According to World Bank reports, only 30% of financial institutions in Central Asia incorporate environmental factors into credit decision-making, reflecting significant implementation gaps. In addition, Asian Development Bank (ADB) data show that green bond issuance in the CAREC region accounts for only 0.8% of the global market and is concentrated in a few countries, particularly Kazakhstan. Although green credit dominates regional green financing (approximately 72% of the total), maturity mismatches persist, with approximately 85% of green loans having maturities of less than five years, limiting their suitability for long-term

infrastructure projects. These structural deficiencies have severely constrained the large-scale development of green industries in the region.

Overall, green finance remains at an early stage of development in CAREC countries. Although policymakers increasingly recognize its potential, practical implementation remains limited due to underdeveloped capital markets, fragmented regulatory systems, and insufficient institutional capacity. Many financial institutions lack the technical expertise needed to assess environmental risks and evaluate green projects. Moreover, the absence of standardized taxonomies, robust disclosure frameworks, and effective regional coordination further hampers market development.

Therefore, examining the relationship between green finance and green transformation is not only of practical relevance but also essential for formulating effective policies, investment strategies, and international cooperation mechanisms.

Figure 1.2. Total approved financing by country and climate and sustainable development sector (USD million)



Data Source: Eurasian Fund for Stabilization and Development <https://efsd.org/>

Figure 1.2 illustrates the distribution of approved financing (in USD millions) across Central and West Asian countries, highlighting allocations to climate and sustainable development sectors. Pakistan emerges as the largest recipient, with funding approaching USD 2,000 million, likely reflecting its large population, high climate vulnerability, and substantial infrastructure needs. Uzbekistan and Mongolia follow, with approximately USD 900 million and USD 750 million, respectively, indicating active energy transition efforts and ongoing institutional

reforms. Georgia and Belarus received moderate levels of financing, ranging between USD 600 and 700 million, while Kazakhstan, the Kyrgyz Republic, Tajikistan, and Armenia secured more modest amounts of approximately USD 250–450 million. In contrast, Azerbaijan, Russia, and Turkmenistan received less than USD 150 million, possibly due to limited project pipelines, institutional barriers, or lower engagement in climate-related financing mechanisms.

This report aims to examine the role of green finance in promoting the green transition in CAREC countries. The remainder of the report is organized as follows:

I. Green transition strategies in CAREC countries. This section reviews the current status of green transition strategies in CAREC countries, focusing on energy consumption structures and policy trends related to decarbonization. It identifies the major challenges faced by these countries in pursuing low-carbon development.

II. Green finance development in CAREC countries. This section provides a detailed analysis of green finance policies and financial instruments in the region. It evaluates the overall policy framework, the availability and use of green finance instruments (e.g., green bonds, credit lines, and funds), and existing governance and regulatory support mechanisms.

III. The role of green finance in supporting the green transition. This core section examines how green finance currently influences green transformation efforts in CAREC countries. It assesses the impact of green finance flows on clean energy investment, industrial modernization, and low-carbon innovation, and identifies key barriers limiting the effectiveness of green finance interventions.

IV. Policy recommendations and regional cooperation strategies. Based on the empirical findings, this section proposes practical policy recommendations to strengthen the use of green finance instruments in addressing green transformation challenges in CAREC countries. It also presents selected case studies from within and outside the region to illustrate best practices in green finance and climate cooperation, providing insights for enhancing regional climate-related financial integration.

Based on these findings, the report seeks to support CAREC policymakers, development institutions, and financial actors in designing more effective strategies to balance economic development with environmental sustainability.

1.2 Methodology

This report employs the Improved Entropy Method (IEM) to assess the comprehensive level of green finance development in China. First, the raw data are standardized. For positive indicators, where higher values indicate better performance, standardization is performed by subtracting the minimum value and dividing by the range. For negative indicators, the procedure is reversed to reflect that lower values represent better performance.

To ensure that all standardized values are positive and to avoid logarithmic errors, a small constant ($\theta = 0.0001$) is added to each value. The adjusted values are then converted into proportions (P_{ij}), which reflect the relative performance of each observation under a given indicator.

Next, the entropy value (D_j) of each indicator is calculated. D_i measures the information utility of each indicator: lower entropy values indicate greater variability and higher information content. Entropy redundancy (G_j) is then computed as 1 minus the entropy value, representing the relative importance of each indicator. The weight (w_j) of each indicator is calculated by normalizing G_j .

Finally, the comprehensive green finance index (U_j) is calculated as the weighted sum of all standardized indicators, reflecting the overall level of green finance development in China.

2. Green transition strategies in CAREC countries

The CAREC region comprises Afghanistan, Azerbaijan, China, Georgia, Kazakhstan, Kyrgyzstan, Mongolia, Pakistan, Tajikistan, Turkmenistan, and Uzbekistan. Together, these countries form a vast, resource-rich corridor that plays a vital role in regional energy production, distribution, and trade. Several countries, including Kazakhstan, Turkmenistan, and Azerbaijan, possess extensive fossil fuel reserves, while others, notably Tajikistan and Kyrgyzstan, have significant hydropower potential. As one of the world's largest energy consumers, China is also a global leader in renewable energy technology development.

These characteristics have resulted in a complex and diverse regional energy landscape. CAREC countries differ significantly in terms of energy supply, demand patterns, infrastructure development, and renewable energy policy orientations.

To assess the sustainability and resilience of energy systems in CAREC countries, it is essential to investigate both energy composition (supply) and energy consumption structures. These

dimensions are undergoing rapid change due to population growth, technological advancement, regional cooperation, economic transformation, and international climate commitments.

2.1 Energy consumption structure of CAREC countries

2.1.1 Primary Energy Supply Trends in CAREC Countries

Between 2020 and 2030, total primary energy supply in CAREC countries is projected to grow significantly, although the pace of growth varies across scenarios and regions. Excluding the People's Republic of China (PRC), CAREC member countries are expected to experience average growth of approximately 30%, rising from 280 million tons of oil equivalent (toe) in 2020 to between 334 and 402 million toe by 2030.

Under the Green Growth scenario, which emphasizes aggressive energy efficiency measures, annual growth is constrained to approximately 1.9%. In contrast, the Government Commitments and Business-as-Usual (BAU) scenarios project higher annual growth rates of 2.4% and 3.5%, respectively. Natural gas is expected to dominate the energy mix across all scenarios, increasing its share to 43%–48% by 2030, driven by its widespread use in power generation and industrial and residential consumption.

Meanwhile, the share of renewable and nuclear energy sources is projected to triple under the Government Commitments scenario. When the PRC is included, total primary energy supply in the CAREC region is forecast to increase by approximately 12%, reaching 3,859–4,086 million toe by 2030, depending on the scenario. Although coal will remain a major energy source, its share is expected to decline to 36%–44%, reflecting a gradual shift toward cleaner alternatives.

Renewable and nuclear energy are anticipated to increase from 15% of the primary energy mix in 2020 to between 22% and 33% by 2030. Despite changes in energy supply and composition, cumulative economic growth across the CAREC region, including the PRC, is expected to remain robust, with GDP growth averaging 3.3% in 2020 and potentially reaching 8.5% annually under optimistic scenarios through 2030.

2.1.2 Final Energy Demand by Fuel in CAREC Countries

Final energy demand in CAREC countries is projected to grow substantially by 2030, with notable regional and scenario-specific variations. Excluding the PRC, demand is expected to

rise by approximately 32%, from 204 million toe in 2020 to between 254 and 290 million toe, depending on the extent of energy efficiency implementation.

Electricity and natural gas are anticipated to experience the fastest growth, particularly in the residential and industrial sectors. While coal and oil shares remain relatively stable under the BAU scenario, they are projected to decline under both the Government Commitments and Green Growth scenarios, most markedly under the Green Growth scenario, where coal's share falls from 10% to 5%. In absolute terms, coal consumption continues to increase under BAU due to overall demand growth but declines under the Green Growth scenario as natural gas substitutes for coal.

Including the PRC, final energy demand in the CAREC region is expected to increase by approximately 10%, reaching 2.4–2.7 billion toe by 2030. Natural gas is forecasted to expand most rapidly, growing at 3%–4% annually and capturing a 10%–13% share of final demand. Electricity's share also increases across all scenarios, while oil demand remains stable or grows moderately due to continued transportation needs. Coal consumption is expected to decline in all scenarios, driven primarily by the PRC's strategic efforts to limit its use despite ongoing reliance on coal for power generation.

2.1.3 Final Energy Demand by Sector in CAREC Countries

From a sectoral perspective, the transport sector is projected to be the fastest-growing energy consumer in CAREC countries excluding the PRC, with demand increasing at a compound annual growth rate (CAGR) of 3%–4% by 2030, depending on the scenario.

In contrast, energy demand in the residential and industrial sectors is anticipated to grow more moderately, at approximately 2%–3% annually, reflecting the impact of targeted energy efficiency measures. When the PRC is included, the transport and residential sectors remain the primary drivers of energy demand growth, with projected CAGRs of 2%–3% and 2%–4%, respectively, by 2030.

2.2 Green transition trends of CAREC countries

Energy policies and development plans of CAREC countries are closely linked to the green transition process. In practice, most of these countries remain highly dependent on fossil fuels to meet their energy needs. At the same time, increasing climate-related pressures are accelerating efforts to expand renewable energy adoption. Although progress toward green

transition varies across countries, the region as a whole is moving gradually toward a cleaner energy system. Accordingly, this section explores the main trends, opportunities, and challenges facing the CAREC region in its green transition.

Table 2.1 Overview of energy transition status across CAREC countries

Country	Green Transition Status	Renewable Energy Targets	Main Renewable Sources	Key Progress	Major Challenges
Kazakhstan	Leading in Central Asia	15% by 2030, 50% by 2050	Wind, Solar	Policy frameworks, auctions	Heavy coal reliance, aging infrastructure
Uzbekistan	Rapid progress	25% by 2030	Solar, Wind	Successful auctions, foreign investment	Low energy efficiency, fossil fuel dominance
Turkmenistan	Minimal progress	No official targets	Negligible	Focus on gas exports	Weak climate policy, lack of transparency
Kyrgyzstan	Hydropower leader	Maintain high share	Hydropower	90% electricity from hydropower	Water variability, limited diversification
Tajikistan	Clean power system	Maintain ~95% hydropower	Hydropower	Among the cleanest energy mixes	Winter shortages, climate risk
Azerbaijan	Early diversification	30% by 2030	Solar, Wind	Large-scale foreign partnerships	Oil and gas dependency
Georgia	Moderate progress	Increase renewable share	Hydropower, Wind	Over 60% from hydropower	Financing gaps, energy security concerns
Mongolia	Strong potential	30% by 2030	Wind, Solar	Grid-connected projects with ADB support	Coal dependence, harsh climate

Pakistan	Scaling up investments	60% renewable electricity by 2030	Solar, Wind, Hydro	Large hydropower projects, policy reforms	Grid instability, fossil fuel subsidies
Afghanistan	Very limited but vital	No unified target	Solar, Small Hydro	Donor-funded off-grid projects	Conflict, limited infrastructure
China (West)	Global leader, regional gaps	Carbon neutrality by 2060	All types (esp. solar/wind)	Large-scale renewable deployment	Continued coal dependence in Xinjiang

Sources: Satubaldina, A. (2025, February 13). Renewables expose weaknesses in Kazakhstan’s power sector, transform mindsets. The Astana Times.

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Overall, green transition efforts in CAREC countries are progressing but remain uneven and constrained by systemic challenges. Countries such as Turkmenistan and Afghanistan require substantial international support and domestic institutional reform, while others, including Kazakhstan, Uzbekistan, and Mongolia, have made measurable progress in diversifying their energy mixes.

Countries with abundant hydropower resources are well positioned for low-carbon development but remain vulnerable to climate-related risks. Meanwhile, fossil fuel-exporting countries face difficult trade-offs between decarbonization and economic dependence on hydrocarbons.

Strengthening policy coordination, mobilizing investment, promoting technology transfer, and advancing inclusive energy planning are critical to the success of regional transformation. Over the next decade, building resilient low-carbon energy systems aligned with global climate goals and sustainable development priorities will be essential for CAREC countries.

2.3 Challenges of green transition in CAREC countries

The transition to a low-carbon economy in the CAREC region is both essential and demanding. Despite broad recognition of the urgency of climate action, multiple interrelated institutional, structural, economic, and geopolitical barriers hinder progress toward sustainability.

(1) Heavy reliance on fossil fuels and carbon-intensive economies

Many CAREC countries, particularly Kazakhstan, Turkmenistan, Uzbekistan, and Azerbaijan, rely heavily on fossil fuel extraction and exports. For example, Kazakhstan derives over 60% of its export revenues from oil and gas, while Turkmenistan's gas sector accounts for more than 30% of GDP. In addition, fossil fuel subsidies persist, distorting market incentives and delaying energy diversification.

This dependence makes green transition policies economically and politically sensitive, especially when they threaten government revenues, employment, or the stability of state-owned enterprises.

(2) Limited institutional and regulatory capacity

Several CAREC countries lack well-established institutional frameworks to support green development. Key challenges include: (i) the absence of national green finance strategies and taxonomies (e.g., in Kyrgyzstan, Tajikistan, and Turkmenistan); (ii) weak enforcement of

environmental regulations due to overlapping mandates and limited monitoring capacity; and (iii) incomplete monitoring, reporting, and verification (MRV) systems for tracking emissions and green investments. As a result, climate-related policies are often fragmented and inconsistent across sectors and government levels.

(3) Inadequate access to green finance and investment

Despite global growth in green finance, most CAREC countries struggle to attract climate-aligned capital due to underdeveloped capital markets, limited availability of green financial instruments, high perceived risks associated with long-term infrastructure investments, and weak project preparation capacity. Consequently, generating bankable renewable energy and climate adaptation projects remains difficult. While multilateral institutions such as ADB, EBRD, GCF, and World Bank are actively involved, domestic financial institutions have yet to fully engage in green financing mechanisms.

(4) Energy infrastructure and technological lock-in

Aging and carbon-intensive infrastructure dominates CAREC energy landscape, presenting significant challenges to green transition. In countries such as Kazakhstan and Uzbekistan, over 75% of electricity is generated from fossil fuels, contributing to high emission levels. Transmission and distribution losses remain substantial, particularly in rural areas of Tajikistan and Afghanistan, exacerbating inefficiencies. In cold-climate urban areas, widespread reliance on coal-based heating systems further reinforces carbon lock-in. Replacing these outdated systems with clean alternatives requires substantial upfront investment, representing a key barrier to rapid and effective decarbonization.

Table 2.2 Energy infrastructure and technological lock-in in CAREC region

Indicator	Value / Status
Energy demand (2020, excluding China)	204 Mtoe → Projected +30–32% by 2030 (≈ 254–290 Mtoe) (Daryo.uz)
Installed hydropower capacity	~380 GW (2019 estimate, CAREC region; Daryo.uz , Development Asia)
System energy losses	Up to ~20% in aging grid networks (Eurasian Research , Daryo.uz)

Required capacity addition (2030)	~192 GW total, including ~153 GW from renewables (CAREC Institute)
Investment gap	USD 340 billion (excl. China); USD 2.9–3.8 trillion (incl. China) (Daryo.uz , Wikipedia)
Market integration	Regional declaration signed (2019, Tashkent); implementation progressing slowly (CBW , CARECP Energy)

Source: CAREC Energy Outlook 2030, ADB CAREC Energy Strategy and Development, Asia. Eurasian Research Institute report and CAREC Energy Program (energy.carecprogram.org), and CAREC Institute Report (2024): "Sustainable Pathways to Energy Transition in the CAREC Region: A Governance Perspective," CAREC Institute. CAREC countries face substantial technological lock-in driven by reliance on legacy Soviet-era infrastructure, hydropower dominance, weak regional energy markets, and regulatory inertia. Energy demand is projected to increase by approximately 30% by 2030, requiring massive investment (~USD 340 billion) and a significant shift toward renewable energy. While institutional and policy reforms are underway, overcoming technological lock-in will require accelerated governance modernization, increased private-sector participation, grid modernization, and enhanced regional coordination.

(5) Geopolitical and economic instability

The CAREC region is vulnerable to regional security concerns, trade tensions, and political instability, particularly in Afghanistan and parts of the Caspian Basin. These factors undermine investor confidence in long-term infrastructure projects, as political and economic uncertainty increases investment risks. Additionally, national priorities frequently shift toward short-term stabilization measures, diverting attention and resources away from long-term development objectives such as environmental sustainability. This situation also jeopardizes regional cooperation on shared challenges, including transboundary air pollution and cross-border water management, which require coordinated and sustained collaboration.

(6) Lack of public awareness and human capital

In addition to financial and technological investment, the green transition requires behavioral change and high-quality human capital. However, in many CAREC countries, limited public awareness of energy efficiency, climate change, and sustainable practices hampers widespread

adoption. Furthermore, educational and training institutions have not yet fully integrated green skills, climate literacy, or sustainability-focused curricula, leaving the workforce insufficiently prepared for the demands of a green economy. Communities that are heavily dependent on fossil fuels also lack adequate and inclusive just transition plans, making them vulnerable to the socioeconomic impacts of decarbonization. As a result, human capital constraints severely limit implementation capacity and weaken grassroots support for green transformation across the region.

(7) Data gaps and inadequate climate risk assessments

Reliable climate and environmental data are essential for designing effective green transition strategies. However, in many CAREC countries, climate vulnerability assessments remain outdated or incomplete, limiting policymakers' ability to understand and respond to local environmental risks. Financial institutions often lack appropriate tools to evaluate climate-related credit and operational risks, hindering the integration of environmental factors into financial decision-making. In addition, open data platforms are frequently underdeveloped or poorly maintained, restricting access to reliable environmental information for governments and businesses. Without robust, evidence-based data systems, stakeholders face difficulties in prioritizing high-impact interventions and making informed decisions necessary to advance green transformation.

3. Green finance development in CAREC countries

3.1 Background of green finance policies and products

Green finance refers to financial investments directed toward sustainable and climate-resilient projects, including renewable energy, energy efficiency, sustainable transport, and climate adaptation. For CAREC countries, aligning financial systems with green investment priorities is essential for driving large-scale energy transitions, reducing emissions, and enhancing climate resilience.

Table 3.1 Overview of green finance status across CAREC countries

Country/Institution	Green Finance Activity	Funding/Capital
Kazakhstan	AIFC Green Centre, green bonds, KazREFF	US \$0.48 M + €70 M
China	National green bond market, BRI green funds	US \$489 B (by 2022)
Eurasian Development Bank	Renewable energy financing and green bonds	USD 540 M (2017–2020); pipeline USD 1 B
CAREC (regional)	CSPPF, ReCATH, CACIP, training programs	Multi-donor trust; 26 workshops (2023)
Other CAREC members	Limited domestic instruments; reliance on multilaterals	World Bank, GIZ, USAID, EU

The table highlights significant variation in green finance development across CAREC countries and institutions, reflecting differences in national capacity and levels of international support. Kazakhstan has emerged as a regional leader through initiatives such as the AIFC Green Finance Centre and the KazREFF facility, supported by funding of US \$0.48 million and €70 million. China, with its sophisticated national green bond market and Belt and Road Initiative (BRI) green funds, has mobilized approximately US \$489 billion by 2022, making it one of the largest green finance players globally. The Eurasian Development Bank (EDB) has supported renewable energy projects and green bonds, providing USD 540 million between 2017 and 2020 and preparing a future pipeline worth USD 1 billion.

At the regional level, CAREC has launched platforms such as CSPPF, ReCATH, and CACIP, alongside 26 training workshops in 2023, all funded through a multi-donor trust. Meanwhile, other CAREC members—including Uzbekistan, Kyrgyzstan, Tajikistan, and Turkmenistan—still lack domestic green financial instruments and rely heavily on multilateral donors such as the World Bank, GIZ, USAID, and the EU for project financing and capacity building. While some countries are advancing rapidly, the region as a whole continues to face challenges related to institutional capacity, policy frameworks, and access to capital, underscoring the need for coordinated efforts to scale up green finance and enable a just and inclusive green transition.

Green finance in the CAREC region is transitioning from concept to practice. With early successes in Kazakhstan and China, along with strong institutional involvement from the ADB, EDB, EBRD, and other multilateral development banks (MDBs), a growing pipeline of clean energy and climate resilience projects is emerging. However, large-scale deployment requires deeper financial markets, standardized instruments, stronger policy environments, and enhanced regional coordination. Mobilizing green finance across CAREC is therefore essential to unlock renewable energy potential, strengthen climate resilience, and promote sustainable development across Central and South Asia.

3.1.1 Green finance policies in CAREC countries

The development of green finance policy across CAREC countries is gradually gaining momentum as part of broader efforts to support sustainable economic growth and address climate change challenges. Although the level of policy development varies significantly among member states, there is an emerging trend toward integrating environmental sustainability into financial sector planning and investment frameworks.

In more advanced CAREC members, such as Kazakhstan and China, comprehensive green finance strategies and regulatory instruments have been established. To promote sustainable finance, Kazakhstan has established the Astana International Financial Centre (AIFC) Green Finance Centre and adopted the Green Economy Concept (2013–2050). These initiatives include developing green bond guidelines, assessing environmental risks, and building capacity among market participants.

In China, a strong policy ecosystem—including a national green taxonomy (“Green Bond Supported Project Catalogue”), mandatory environmental disclosure by financial institutions, and the integration of sustainability considerations into monetary policy—has made the country a global leader in green finance. The Chinese model also encourages outbound green investment through cross-border financing, particularly under the BRI, thereby influencing other CAREC countries.

In contrast, CAREC members such as Uzbekistan, Kyrgyzstan, Tajikistan, Georgia, and Mongolia remain in the early stages of policy development. Although these countries have formulated national climate strategies and renewable energy roadmaps, many lack comprehensive green finance regulatory frameworks. Central banks and finance ministries

occasionally engage in discussions on sustainable banking with support from multilateral institutions such as the World Bank, ADB, and United Nations Development Programme. However, weak domestic capital markets, the absence of standardized green finance taxonomies, and limited institutional capacity continue to constrain effective policy implementation.

The CAREC program, promoted by the ADB, has begun to address these gaps at the regional level through technical assistance, knowledge platforms, and policy coordination initiatives. Further progress will require the development of national green finance taxonomies, stronger regulatory supervision, enhanced institutional capacity, and deeper regional cooperation. These policy foundations are essential for mobilizing resources for climate resilience, renewable energy, and green infrastructure development across the CAREC region.

Table 3.2 Green Finance Policies in CAREC Countries

Country/Region	Key Green Finance Policies	Policy Status	Focus Areas	Implementation Tools
China	Green Bond Endorsed Project Catalogue- PBoC Environmental Risk Guidelines; BRI Green Investment Principles	Advanced	Green bonds, taxonomy, green credit, outbound green finance	Mandatory disclosures, policy guidance, tax incentives
Kazakhstan	Green Economy Concept (2013–2050); AIFC Green Finance Guidelines; National SDG Framework	Moderate to Advanced	Green bonds, clean energy, energy efficiency	AIFC Green Centre, PPPs, blended finance
Uzbekistan	National Strategy on Transition to Green Economy (2019–2030); Energy Efficiency Law	Developing	Renewable energy, sustainable agriculture	State Development Bank programs, donor-funded pilots
Mongolia	Green Finance Roadmap (2018); Mongolia Sustainable Finance Principles (MSFP)	Moderate	Banking sector sustainability, green lending	MSFP network (private banks), green loan guidelines
Kyrgyzstan	Climate Investment Program (in development); National Sustainable Development Strategy	Early stage	Hydropower, adaptation, forest management	Multilateral funding, capacity-building workshops

Tajikistan	Renewable Energy Law; National Climate Change Strategy	Early stage	Resilience, low-carbon energy	External donor support, limited domestic instruments
CAREC (Regional)	CAREC Green Financing Framework; CACIP; ReCATH	Coordination focused	Regional alignment, knowledge sharing	ADB technical assistance, multi-donor trust funds

The table presents a comparative overview of green finance policies across selected CAREC countries, highlighting disparities in institutional development and policy maturity. China stands out for its comprehensive green finance framework, which includes international green investment standards under the BRI, environmental risk guidelines, and a national green bond taxonomy. Kazakhstan's policy framework ranges from moderate to advanced, supported by the AIFC's green finance initiatives.

Mongolia and Uzbekistan have made notable progress through national roadmaps and strategies that promote renewable energy and sustainable banking, although they continue to rely on donor support. In contrast, Kyrgyzstan and Tajikistan remain at an early stage of development, characterized by fragmented policy initiatives and a strong reliance on multilateral assistance for implementation. At the regional level, CAREC promotes harmonization and capacity building through initiatives such as the Green Financing Framework, CACIP, and ReCATH. These efforts aim to align member states with international green finance standards and foster regional cooperation in climate-resilient development.

3.1.2 Green finance products in CAREC countries

A systematic review of the regulatory landscape is crucial for understanding the development of cross-sectoral and cross-market green finance systems. Table 3.3 summarizes key regulations and institutional arrangements related to financial markets, financial institutions, and associated industries in CAREC countries.

Table 3.3 Regulatory green finance instruments in CAREC countries

Sector	Regulations	Relevance to Green Financing
Financial Markets	China: Green Bond Endorsed Project Catalogue (2015), Green Finance Guidelines (2016)	Provides guidelines for green bond issuance and promotes transparency and standardization.
	Pakistan: Securities and Exchange Commission of Pakistan (SECP) Green Bond Guidelines (2020)	Facilitates green bond issuance, with a focus on renewable energy and energy efficiency.

	Kazakhstan: Green Finance Framework (2020)	Establishes standards for green finance products, particularly green bonds and ESG investments.
Financial Institutions	China: Green Credit Guidelines (2012); Environmental Risk Management Guidelines (2021)	Supports sustainable lending and incorporates environmental risks into credit assessments.
	Kazakhstan: National Bank Green Finance Policies (2020)	Encourages banks to integrate green finance into lending activities
	Uzbekistan: Green Banking Policy (2020)	Promotes environmentally sustainable banking practices.
Renewable Energy (FDI)	China: Renewable Energy Law (2005); Foreign Investment Catalogue (2019)	Promotes investment in renewable energy and green technologies.
	Pakistan: Alternative Energy Development Board (AEDB) Policies (2006)	Facilitates foreign investment in wind, solar, and hydropower.
	Mongolia: Law on Renewable Energy (2015)	Encourages renewable energy investment through incentives.
Public-Private Partnerships (PPP)	Azerbaijan: PPP Law (2016); Low-Carbon Development Strategy (2016)	Promotes energy efficiency and clean energy projects.
	Kazakhstan: PPP Law (2015); PPP Development Program (2021)	Supports green infrastructure development.
	Pakistan: Public-Private Partnership Authority (PPPA) Act (2017)	Facilitates public-private collaboration for green projects.

Green Budgeting	China: Green Finance Development Fund (2021)	Allocates public funds to low-carbon and sustainable projects.
	Kazakhstan: Green Budgeting Guidelines (2020)	Aligns fiscal policy with environmental objectives.
	Uzbekistan: Environmental Tax Law (2020)	Provides tax incentives for green investments.
Carbon Pricing and Emissions Trading	China: National Emissions Trading System (ETS) (2021)	Implements carbon pricing to incentivize emissions reductions.
	Pakistan: Carbon Pricing Framework (2020)	Introduces mechanisms to regulate CO ₂ emissions.
	Kazakhstan: Emission Trading System	Operates a cap-and-trade market to reduce industrial emissions.

Source: Compiled by the authors.

The development and deployment of green finance products across CAREC countries represent a critical component of efforts to advance sustainable development, accelerate the green transition, and achieve climate goals. While the regional landscape remains uneven, a growing range of green financial instruments is emerging—particularly in more developed CAREC economies—with significant support from international development partners and regional institutions.

Table 3.4 Green finance products in CAREC countries

Country	Instrument Type	Volume / Amount	Year(s)	Notes
Kazakhstan	Green bonds and loans	~US \$1.2 B (end 2023)	Up to 2023	Via AIFC-certified instruments
Kazakhstan	Green loans	US \$183M → ~US \$437.6M	2021 → ~2024	Growth tracked by AIFC and financial markets
Kazakhstan	ESG bond issuance (2023)	~US \$431.3 M	2023	Listed on KASE/AIX
Kazakhstan	Flagship sustainable projects	> US \$650 M (total)	Since 2020	18 projects across four CAREC countries
Azerbaijan	First green bond (UNIBANK)	AZN 20M (~US \$11.8M)	2023–2025	AIFC-supported issuance
Uzbekistan	Green corporate bonds (UzMRC)	UZS 50B (~US \$4M)	Sept 2024	First domestic green bond
Uzbekistan	Sovereign green Eurobonds	UZS 4.25T (~US \$660M)	Oct 2023	First CIS sovereign green bonds

Source: AIFC Green Finance Centre – Sustainable Finance Casebook, Astana Times – Why Is Sustainable Finance Vital for Central Asia’s Growth?, Kursiv Media – Green Investments in Kazakhstan, AIFC News – Green Finance Market in Kazakhstan, Uzbekistan Mortgage Refinancing Company (UzMRC) – Green Bond Press Release, UNDP Uzbekistan – Sovereign Green Eurobonds, Uzdaily – How Green Finance Is Developing in Central Asia, and AIFC Casebook – UNIBANK Green Bond

Green finance in CAREC countries is gaining momentum, led by Kazakhstan and Uzbekistan, with emerging activity in Azerbaijan. By 2023, Kazakhstan has issued more than US \$1.2 billion in green bonds and loans, including ESG bonds worth approximately US \$431 million in 2023 alone and over 18 flagship projects totaling more than US \$650 million. Green loan volumes in the country more than doubled between 2021 and 2024.

Uzbekistan has pioneered sovereign green finance in Central Asia by issuing US \$660 million in green Eurobonds on the London Stock Exchange in 2023, followed by its first domestic green bond (US \$4 million) in 2024 through UzMRC. Azerbaijan entered the market with a US \$11.8 million green bond issued by UNIBANK. These developments reflect a growing regional commitment to sustainable investment, although the overall market remains at an early stage, with significant scope for expansion and harmonization.

Green bonds are currently the most widely adopted green finance instrument in the CAREC region, particularly in countries such as China and Kazakhstan. China has become one of the world's largest green bond markets, with issuance exceeding \$489 billion by 2022. These bonds support projects in energy efficiency, green transportation, and renewable energy development. Kazakhstan has followed this model by establishing its first green bond framework through the AIFC Green Finance Center and actively promoting local bond issuance in line with international standards to attract institutional investors.

In the area of green credit, the European Bank for Reconstruction and Development and the Green Climate Fund jointly finance solar and wind power projects through Kazakhstan's KazREFF platform. Uzbekistan has also begun piloting preferential green credit lines for sustainable agriculture and energy efficiency. In Mongolia, the adoption of the Mongolian Sustainable Finance Principles has enabled several local banks to provide targeted green loans for environmentally friendly transport and green buildings.

Sustainable investment funds are also gaining traction. China has established green funds under its BRI to promote environmentally friendly infrastructure across Eurasia, including CAREC countries. Although these funds are predominantly state-led, private sector interest in ESG-aligned investments is increasing, particularly in countries with more developed financial markets.

Guarantees and risk-sharing mechanisms have begun to emerge in donor-supported projects, particularly in Kyrgyzstan and Tajikistan, where low investor confidence and undeveloped capital markets hinder green finance expansion. Instruments such as partial credit guarantees, insurance schemes, and performance-based grants are employed to reduce investment risks and attract private capital.

Despite these positive developments, green finance products remain limited in several CAREC member countries, particularly where regulatory frameworks, capital markets, and institutional capacities are still evolving. Many financial institutions lack the technical expertise to design and market green products, while private investors remain cautious due to uncertain returns and perceived risks.

To scale up green financial products, CAREC countries need to harmonize definitions through national green taxonomies, strengthen transparency and monitoring frameworks, and incentivize product innovation through supportive policies and regulations. Regional cooperation—supported by multilateral institutions such as the ADB and EBRD—will be essential for sharing best practices, enabling standardization, and expanding innovative instruments, including green sukuk, carbon trading mechanisms, and ESG-linked loans.

In conclusion, while CAREC countries are at varying stages of developing green finance products, meaningful progress is underway. Green bonds, concessional loans, and green investment funds are increasingly shaping the regional sustainable finance landscape, particularly in leading economies such as China and Kazakhstan. For other member states, continued capacity building and regulatory reform remain critical to unlocking the full potential of green finance and mobilizing capital for a low-carbon future.

Table 3.4 Green finance products in CAREC countries vs. global practices

Green finance products	CAREC countries	Global context
Green Bonds	China: Largest issuer in CAREC; over USD 489 billion issued by 2022. Kazakhstan: AIFC-supported issuance since 2020.	Widely adopted globally. Major issuers include the US, EU, China. Market value exceeded USD 2.5 trillion by 2023.

	Other countries: Limited or pilot-stage activity.	
Green Loans	Kazakhstan and Uzbekistan: Concessional loans via KazREFF, World Bank, and EBRD. Mongolia: Green lending guided by MSFP. Limited adoption elsewhere.	Common in the EU, US, and Japan. Often linked to sustainability performance metrics and targets.
Sustainable Investment Funds	China: Green funds under the BRI. Kazakhstan: Emerging ESG-aligned funds. Other CAREC countries: Minimal activity.	Rapid growth worldwide. ESG funds surpassed USD 2 trillion in assets under management in 2023.
Carbon Markets/Trading	China: National Emissions Trading System (ETS) launched in 2021. Other CAREC countries: No formal carbon markets.	EU ETS is the most advanced. Over 30 carbon pricing schemes are in operation worldwide.
Sukuk (Green Islamic Bonds)	Not yet implemented in CAREC, though potential exists in Muslim-majority countries (e.g., Uzbekistan and Kazakhstan).	Issued in Malaysia, the UAE, and Saudi Arabia. Growing demand in Islamic finance markets.
Sustainability-Linked Loans	Not yet formalized in CAREC. Under consideration in some countries (e.g., through ADB consultations).	Widely used by global corporations. Tied to borrowers' sustainability KPIs.
Guarantees and Risk-Sharing Mechanisms	Donor-led guarantees in Tajikistan and Kyrgyzstan for green infrastructure. Largely pilot or project-based.	Common in blended finance structures. Used to de-risk green investments in developing economies.
Green Taxonomies and Standards	China: Well-developed taxonomy and disclosure rules.	The EU, China, and ASEAN have established taxonomies.

Other CAREC countries: Draft or absent; working toward alignment.	International convergence is underway (e.g., via IPSF).
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Green finance product development across CAREC countries remains uneven, with China leading the region with a mature green bond market, a national emissions trading system (ETS), and active green investment funds that align closely with global best practices. Kazakhstan follows with notable progress in green bonds and concessional loans supported by institutions such as the AIFC and EBRD. Mongolia and Uzbekistan are beginning to adopt green loans and sustainable lending frameworks, while countries such as Kyrgyzstan and Tajikistan remain largely dependent on donor-funded guarantees and pilot projects.

Globally, green finance markets are far more advanced, with a wide range of products—including green sukuk, sustainability-linked loans, and comprehensive taxonomies—widely implemented. Most CAREC countries still face significant gaps in regulatory frameworks, product diversification, and investor engagement. However, they are gradually moving toward convergence with global green finance standards through regional coordination and external support.

3.1.3 Green finance risk management in CAREC countries

Effective risk management is a critical component of green finance, ensuring that ESG risks are adequately identified, assessed, and mitigated. In CAREC countries, green finance risk management remains at an early stage of development, with substantial differences in institutional capacity, regulatory readiness, and technical expertise across the region.

China has established a comprehensive green risk management system and maintains the most developed green finance market among CAREC members. The People's Bank of China (PBoC) promotes the integration of ESG considerations into lending decisions and requires financial institutions to disclose environmental risks. China's green taxonomy reduces reputational and transition risks by clearly defining eligible activities and excluding high-carbon projects. In addition, the national ETS enables financial institutions to assess and price carbon-related risks, thereby influencing investment and credit decisions.

In contrast, most other CAREC countries lack well-developed green finance risk management frameworks. Kazakhstan has begun incorporating ESG risk analysis through the AIFC Green

Finance Centre, which provides training and technical support to banks and investors. However, unified requirements for scenario analysis and green risk disclosure remain limited.

In Uzbekistan, Kyrgyzstan, Tajikistan, and Mongolia, green risk management is largely driven by donor initiatives and multilateral project frameworks rather than embedded in national financial regulations. Financial institutions in these countries often lack reliable data and technical expertise for climate risk assessment, limiting their ability to price and manage transition and physical climate risks effectively.

Risk management in many CAREC countries is complicated by the lack of reliable environmental data, unified disclosure frameworks, and standardized green taxonomies. These gaps make it difficult for financial institutions to distinguish between “brown” and “green” assets, thereby increasing the risk of capital misallocation and “greenwashing.” The absence of robust taxonomies also limits the ability of financial market participants to assess environmental risks within their portfolios and to comply with emerging international disclosure requirements, such as those promoted by the Task Force on Climate-related Financial Disclosures (TCFD).

Multilateral organizations, including the EBRD and the ADB, are supporting capacity building in green finance risk management to address these challenges. Their efforts include organizing training workshops for financial regulators and central banks, developing ESG toolkits, and designing climate risk assessment models. In addition, the recently launched CAREC Green Finance Framework aims to promote standardized approaches to risk assessment, disclosure, and sustainable financial integration across the region.

To strengthen green finance risk management, CAREC countries should prioritize the following initiatives: (1) implementing national green taxonomy standards aligned with international practices; (2) requiring financial institutions to disclose ESG and climate-related risks; (3) establishing centralized environmental data systems; and (4) enhancing the technical capacity of regulators and financial institutions. Regional cooperation can further support these efforts by promoting peer learning and coordination through platforms such as CACIP and CAREC's ReCATH.

3.2 Green finance policy and products in CAREC countries

In response to increasing climate vulnerability and growing infrastructure needs, CAREC countries are gradually aligning their financial systems with global climate goals. MDBs, regional financial institutions, and development partners play a critical role in introducing green finance instruments, mobilizing investment, and strengthening institutional capacity across the region.

3.2.1 Asian Development Bank (ADB)

The ADB has committed to allocating 50% of its annual lending portfolio to climate-related projects by 2030, with a cumulative climate finance target of US \$100 billion for the period 2019–2030. As of the latest available data, approximately US \$30 billion has already been delivered under this commitment.

Figure 3.1 Trend of climate finance from the Asian Development Bank (2019–2024)

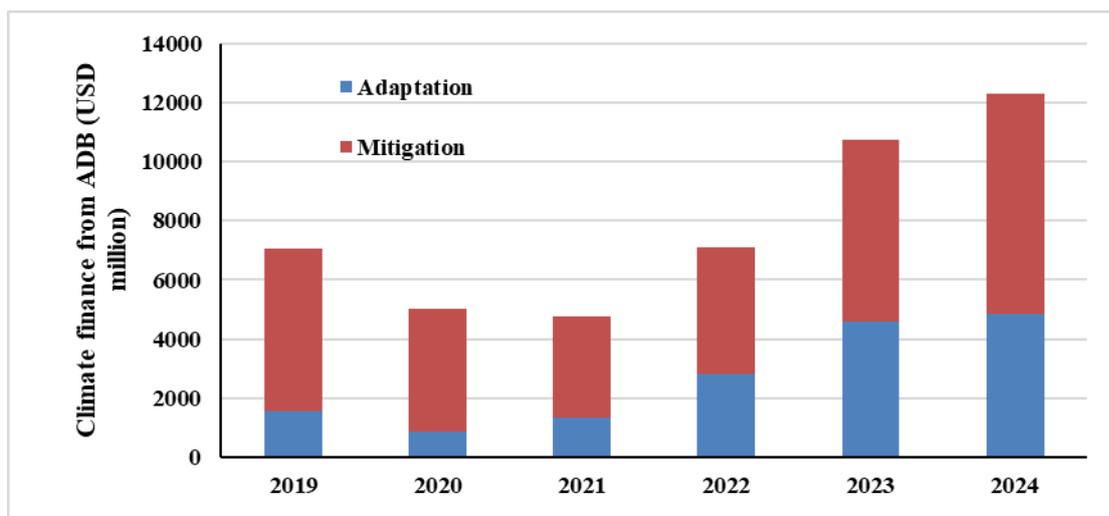
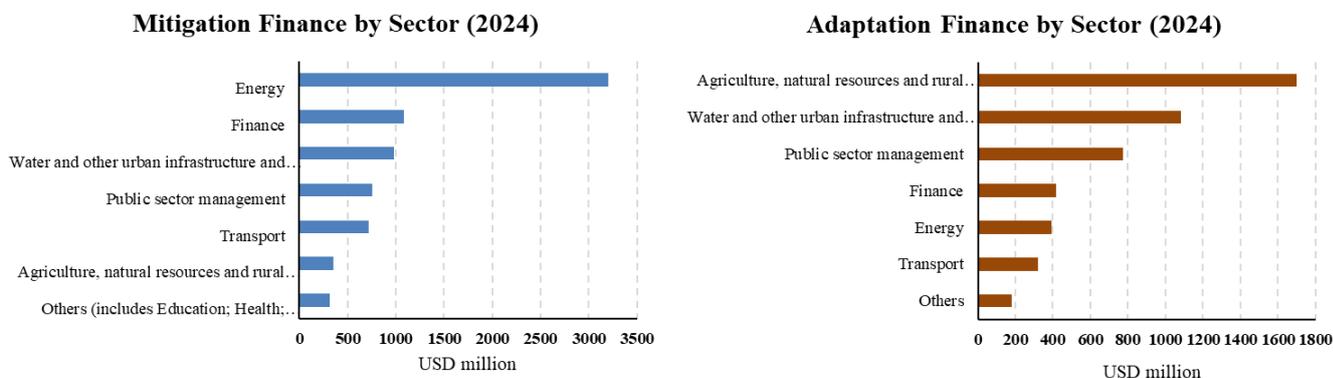


Figure 3.2 Mitigation and adaptation finance by sector at ADB in 2024.



To enhance private sector participation, ADB aims to mobilize US \$13 billion from private sources, including US \$4.5 billion in direct investments. Several innovative financial instruments have been introduced to support this objective. Notably, the Innovative Finance Facility for Climate in Asia and the Pacific (IF-CAP) uses joint guarantees to leverage US \$2.5 billion into an expected US \$11 billion in green investments. In addition, the Climate Action Catalyst Fund (CACF), partially supported by Sweden, seeks to mobilize US \$100 million for carbon market development and climate mitigation projects.

Other instruments include the Blue Bond Incubator, which supports sovereign and corporate blue bond issuance, and the Energy Transition Mechanism (ETM), which provides blended finance to accelerate coal phase-outs and promote clean energy adoption.

At the regional level, ADB has actively supported the CAREC energy and climate agenda. Key initiatives include the Green Energy Alliance, a digital marketplace for clean energy investment, and the Climate and Sustainability Project Preparatory Fund (CSPPF), with an initial contribution of US \$5 million from China and the Republic of Korea. ADB also organized the 6th CAREC Energy Investment Forum in Tbilisi in November 2023 to promote public–private partnerships (PPPs) and green energy investment opportunities.

3.2.2 Islamic Development Bank (IsDB)

The Islamic Development Bank (IsDB) has played a strategic role in advancing green finance in the CAREC region. Under its Climate Action Plan (2020–2025), the Bank allocated 33% of its total approvals to climate-related projects in 2022 and aims to increase this share to 35% by 2025. At COP27, IsDB pledged US \$24 billion in climate finance by 2030, including US \$13 billion specifically earmarked for adaptation and mitigation activities.

As part of its Sustainable Finance Framework, IsDB has issued more than US \$5 billion in green and sustainability sukuk, which have received “Medium Green” ratings from external assessors. In addition, to support inclusive green growth, the Bank launched the Youth Green Skills Accelerator in cooperation with the International Labor Organization, with the aim of strengthening capacity and employment opportunities in the green economy.

3.2.3 European Bank for Reconstruction and Development (EBRD)

The EBRD has pledged to become a “green-first bank” by 2025, ensuring that its investments are fully aligned with the Paris Agreement. In 2020, the Bank invested approximately EUR 3.2

billion in climate mitigation and adaptation projects, with green financing accounting for over 40% of its total investments. In addition, the EBRD plans to extend its mandate to new CAREC countries to support green infrastructure development, policy reforms, and private sector innovation.

3.2.4 Eurasian Development Bank (EDB)

The EDB has incorporated sustainability into its Medium-Term Strategic Framework (2022–2026). It is currently reviewing over USD 600 million in green energy investments, focusing on large-scale transport and water corridor projects. These investments are expected to reduce CO₂ emissions by approximately 5 million tonnes per year.

3.2.5 Other Institutions

The OPEC Fund for International Development works with major MDBs, including the ADB, AIIB, EBRD, IFC, and IsDB, as co-financing partners for infrastructure and climate resilience projects in CAREC countries. In addition, global institutions such as the World Bank, European Investment Bank (EIB), International Monetary Fund (IMF), and United Nations Development Programme (UNDP) provide policy advice, technical assistance, and project preparation support for the implementation of the CAREC 2030 Strategy.

3.2.6 Regional and Capacity-Building Initiatives

Beyond financing, institutional capacity building is a central focus of regional cooperation efforts. In 2024, the Multilateral Cooperation Center for Development Finance (MCDF) and CAREC jointly organized a regional training course in Urumqi, focusing on sustainable debt management, local currency financing, and project development.

Since 2020, the CAREC Institute's Finance Working Group has been developing a funding diversification strategy with support from the ADB, IsDB, World Bank, IMF, and UNICEF. Moreover, a Memorandum of Understanding (MOU) signed between the CAREC Institute and the International Finance Forum (IFF) in 2021 aims to promote cooperation on green infrastructure development across Central Asia.

Table 3.5 Key regional and capacity-building initiatives supporting green finance in CAREC countries

Initiative/Institution	Description	Focus Areas	Year / Status
Multilateral Cooperation Center for Development Finance (MCDF)	Collaborative platform supporting project preparation, policy coordination, and sustainable debt financing	Sustainable debt management, blended finance, local currency financing	Workshops in 2024 (Urumqi)
CAREC Institute	Regional knowledge hub providing analytical support and training to CAREC governments	Financial literacy, green project readiness, public finance	Active since 2015
CAREC Institute Finance Working Group	Cross-institutional platform for developing sustainable financing strategies	Funding diversification, climate-aligned investment policy	Ongoing since 2020
International Finance Forum (IFF) & CAREC Institute (MOU)	Agreement promoting cooperation on green infrastructure and policy dialogue	Green infrastructure finance, public-private partnerships	MOU signed in 2021
CAREC Green Energy Alliance (ADB-led)	Digital marketplace for green energy investment across the CAREC region	Investment matchmaking, clean energy, regional cooperation	Initiated in 2022

The development of green finance in the CAREC region depends not only on capital investment but also on institutional readiness, technical capacity, and cross-border knowledge exchange. To address these needs, regional and international organizations have established targeted capacity-building programs and collaborative platforms to support sustainable financial integration.

The MCDF has been instrumental in enhancing the project preparation capacity of CAREC countries. In 2024, MCDF co-organized workshops in Urumqi focusing on sustainable debt management, local currency financing, and project bankability. These sessions aimed to help national agencies better understand fiscal risks in green investments while equipping them to access blended finance mechanisms more effectively.

The CAREC Institute has played a central role as the region's knowledge and training hub. It supports governments in mainstreaming green finance through policy analysis, technical research, and high-level forums. Its work is closely aligned with the CAREC 2030 Strategy, particularly in the areas of climate-resilient infrastructure development and green public finance management.

In addition, the memorandum of understanding signed between the CAREC Institute and the IFF in 2021 represents an important step toward strengthening regional cooperation in green infrastructure financing. The partnership promotes the sharing of investment standards and the creation of PPP opportunities for climate-resilient projects.

The ADB-supported CAREC Green Energy Alliance, established in 2022, is another innovative initiative. Through its Regional Green Energy Investment Platform, it digitally connects project developers, financiers, and regulators. This platform aims to accelerate private sector participation in clean energy by reducing transaction costs and improving the transparency of bankable projects.

Together, these regional and capacity-building initiatives are creating an enabling environment for sustainable investment, strengthening institutional readiness, and enhancing the absorptive capacity of CAREC countries to utilize green finance effectively.

3.3 Development potential of green finance in CAREC countries

The CAREC region, comprising countries such as Afghanistan, Azerbaijan, China, Georgia, Kazakhstan, Kyrgyzstan, Mongolia, Pakistan, Tajikistan, Turkmenistan, and Uzbekistan, holds significant untapped potential for green finance development. As these nations strive to transition toward more sustainable and resilient economies, green finance has emerged as a critical tool to support climate-friendly investments, low-carbon technologies, and environmentally responsible infrastructure.

3.3.1 Participation of regulatory agencies in international sustainable finance platforms

a. Network for Greening the Financial System (NGFS). While no CAREC central bank is currently a member, institutions such as the ADB and the EBRD are recognized observers. This provides a foundation for future participation by CAREC regulators. Aligning national banking and securities regulators with NGFS principles—particularly scenario-based climate risk assessments—would help standardize disclosure requirements and strengthen sustainable finance frameworks.

b. CAREC Institute and Multilateral Partnerships. Through its Climate Change and Sustainable Energy Program, CAREC has joined global platforms such as CTCN, APAN, and the UNFCCC Nairobi Work Programme. In November 2024, CAREC and MCDF jointly organized a sustainable debt workshop involving Azerbaijan, Mongolia, Pakistan, and other member countries. These collaborations have enhanced awareness of climate finance risks and debt sustainability, improving public-sector readiness for green finance frameworks.

c. CAREC Green Energy Alliance. Endorsed in April 2022 and launched during 2023–2024, the Alliance serves as a digital marketplace for green energy projects, connecting regulators, financiers, and developers across member countries. When integrated with national regulatory systems, this platform can help channel financing toward renewable energy, energy efficiency, and emerging green infrastructure.

3.3.2 Participation of market participants in international sustainable finance initiatives

a. Green Bond Activity. Although CAREC-specific green bond data remain limited, the global green bond market reached US \$588 billion in 2023 and is growing at an annual rate of 5 %, with projections approaching US \$1 trillion by 2033. With Uzbekistan announcing 41 new CAREC projects worth US \$12.6 billion over the next five years—many with green components such as railway electrification and energy corridor development—the region offers strong potential for green bond issuance.

b. Financial Institution Engagement. Financial institutions in the region have begun implementing pilot initiatives. For instance, Mongolian banks have adopted Global Alliance for Banking on Values standards and introduced green lending guidelines with support from the IFC and UNDP. Pakistan’s State Bank has issued green banking regulations, and major

banks have joined UNEP FI. These efforts promote voluntary, sector-led sustainability standards.

c. Public–Private and Regional Funds. The Climate Adaptation and Mitigation Program for the Aral Sea Basin (CAMP4ASB), supported by US \$15 million from the World Bank and the Green Climate Fund, has implemented more than 300 climate-smart agricultural projects in Tajikistan and Uzbekistan, benefiting approximately 40,000 people. In parallel, the CAREC Institute continues to support debt sustainability and green infrastructure project preparation.

d. COP29 Financing Commitments. At COP29 in November 2024, Central Asian leaders—including those from Kazakhstan and Kyrgyzstan—called for US \$2 trillion in climate finance and introduced innovative debt-for-nature swaps. These initiatives have further integrated green finance mechanisms into national policy agendas.

4. The role of green finance in the green transition: China as an example

Green finance plays a key role in accelerating the green transition in CAREC countries. As these countries strive to develop low-carbon and climate-resilient economies, the availability and effective mobilization of sustainable financial resources becomes increasingly critical.

Due to data limitations, this report uses China as a case study to examine the impact of green finance on the green transition. As a global leader in green finance, China's market size, policy framework, and innovative practices are at the forefront worldwide. As of the first quarter of 2025, China's green loan balance had exceeded 40 trillion yuan, and the scale of its green bonds and green insurance markets ranked among the largest globally.

China has established a comprehensive green finance policy system, including classification standards, information disclosure requirements, and incentive mechanisms. It has also actively participated in the formulation of international standards, promoted coordination frameworks such as the China–EU Common Classification Catalogue, and facilitated the cross-border flow of green capital. Consequently, using China as a case study to examine the relationship between green finance and green transformation is both representative and instructive.

On the one hand, China has developed a multidimensional model driven by policy guidance, market mechanisms, and technological innovation through a combination of “top-down” strategic planning and “bottom-up” market initiatives. On the other hand, under the framework of the BRI, China has worked closely with Central Asian countries, and its experience in green

finance provides valuable reference for the region, particularly in areas such as standards alignment, capacity building, and project financing.

This study focuses on enterprise-level green innovation in China, offering a micro-level perspective. Green innovation is crucial for overcoming traditional technological lock-in and driving systemic change. It can significantly reduce clean energy costs, improve resource efficiency, and restructure production factor combinations through technological advancement and industrial integration, thereby transforming environmental constraints into drivers of endogenous growth.

4.1 Overview of green finance instruments in China

Before evaluating the impact of green finance on green innovation, it is necessary to comprehensively and accurately measure the level of development in China. This study applies an Improved Entropy Method (IEM) to construct a multidimensional indicator system. The green finance indicators and corresponding evaluation results are presented in Tables 4.1 and 4.2.

The results indicate that in 2023, the Green Finance Index across China's 30 provincial-level administrative regions showed significant regional disparities, ranging from 0.082 in Shaanxi to 0.256 in Sichuan. The central region performed best, with an average score of 0.179, and Shanxi and Heilongjiang performing exceptionally well.

By contrast, while the eastern region includes high-performing provinces such as Beijing, several provinces, including Hebei, fall below the national average. The western region remained heavily dependent on Sichuan, with seven of the remaining ten provinces performing below the national average.

Table 4.1 Green finance indicator system and measurement methods in China

	Indicator dimension	Specific indicator	Measurement method
Green finance	Green investment	Proportion of investment in environmental pollution control	Investment in environmental pollution control (100 million yuan)/GDP (100 million yuan)
		Proportion of energy conservation and environmental protection expenditure	Fiscal expenditure on energy conservation and environmental protection industry (100 million yuan)/Total fiscal expenditure (100 million yuan)
	Green Bonds	Market capitalization share of environmental protection enterprises	Total market value of A-shared listed environmental protection enterprises (100 million yuan)/Total market value of A-shared listed enterprises (100 million yuan)
		Market capitalization share of high energy-consuming industries	Total market value of the six high energy-consuming industries (100 million yuan)/Total market value of A-shared listed enterprises (100 million yuan)
	Green Credit	Proportion of loans to environmental protection enterprises	Loans to A-share listed environmental protection enterprises/Total loans to A-share listed enterprises
		Proportion of interest expenditure in high energy-consuming industries	Interest expenditure of the six major energy-intensive industries (100 million yuan)/Total industrial interest expenditure
	Green insurance	Proportion of agricultural insurance in total insurance	Agricultural insurance expenditure (100 million yuan)/Total insurance expenditure (100 million yuan)

		Agricultural insurance claims ratio	Agricultural insurance expenditure (million yuan)/Agricultural insurance income (million yuan)
	Carbon finance	Carbon emissions loan intensity	Loan balance (100 million yuan)/Carbon emissions (10,000 tons of CO ₂)

Table 4.2 Green finance index across provinces in China (2023)

Provinces	Green finance index	Provinces	Green finance index
Beijing	0.2364	Henan	0.1245
Tianjin	0.2451	Hubei	0.1814
Hebei	0.2038	Hunan	0.1295
Shanxi	0.1451	Guangdong	0.1158
Inner Mongolia	0.2028	Guangxi	0.1487
Liaoning	0.2158	Hainan	0.1280
Jilin	0.2207	Chongqing	0.2561
Heilongjiang	0.1704	Sichuan	0.1673
Shanghai	0.1233	Guizhou	0.1038
Jiangsu	0.1318	Yunnan	0.0821
Zhejiang	0.1829	Shaanxi	0.0879
Anhui	0.1431	Gansu	0.1998
Fujian	0.1192	Qinghai	0.1176
Jiangxi	0.1451	Ningxia	0.1223
Shandong	0.1890	Xinjiang	0.1916

4.2 Empirical analysis of the impact of green credit policy on China's green innovation

This study uses China as an example to explore the impact of green finance on the green transition. As discussed above, green innovation is crucial for overcoming traditional technological lock-in and driving systemic change. Therefore, we estimate the effect of green credit policy (GCP) on green innovation in China.

Specifically, we use the 2012 Green Credit Guidelines as a quasi-natural experiment to examine the causal impact of the GCP on green innovation. The implementation of the 2012 Guidelines increased financing constraints for enterprises in GCP-restricted industries, leading to more intense competition for loans. In contrast, enterprises in industries not subject to these restrictions experienced relatively little change in financing conditions.

This setting provides an opportunity to apply a difference-in-differences (DID) strategy, as adopted by Zhang et al. (2022b). Accordingly, industrial firms are divided into two groups: firms in GCP-restricted industries (treatment group) and firms in non-restricted industries

(control group). By comparing differences in innovative activities between these two groups before and after 2012, we identify the impact of the GCP on firms' green innovation.

The DID estimation model is specified as follows:

$$\ln Patent_{it} = \beta_0 + \beta_1 Treat_i + \beta_2 Treat_i \times Post_t + \beta_3 Post_t + \gamma x_{it} + \alpha_i + \theta_t + \varepsilon_{it} \quad (1)$$

where i and t denote firm and year, respectively. $\ln Patent_{it}$ represents the green innovation performance of firm i in year t , measured by the number of green patent filings. In practice, green patents are classified into green invention patents and green utility model patents. Following Li et al. (2022), we use green invention patent filings ($GIFs$) to measure the quality of green innovation, green utility model patent filings ($GUFs$) to measure the quantity of green innovation, and total green patent filings ($TGFs$), calculated as the sum of $GIFs$ and $GUFs$, to measure overall green innovation performance. The vector x_{it} includes a set of control variables, and ε_{it} denotes the error term.

To reduce potential heteroskedasticity caused by data fluctuations, we apply a logarithmic transformation to the outcome variable. Because many firms reports zero patent filings, we use the following transformation:

$$\ln Patent_{it} = \ln(PATENT_{it} + 1) \quad (2)$$

where $\ln Patent_{it}$ refers to $\ln Total$, $\ln Inven$, and $\ln Utim$ when $PATENT_{it}$ represents $TGFs$, $GIFs$, and $GUFs$, respectively.

The China Banking Regulatory Commission (CBRC) has specified the classification of firms according to their environmental and social risk levels in the Key Evaluation Indicators of Green Credit Implementation. Accordingly, we identify Class A industries, which face high environmental risks, as GCP-restricted industries. $Treat_i$ is a dummy variable equal to 1 if firm i belongs to Class A and 0 otherwise. $Post_t$ is an indicator variable for the post-GCP period, which equals 1 from 2012 onward and 0 otherwise. The interaction term $Treat_i \times Post_t$ is our key explanatory variable, and its coefficient (β_2) directly reflects the net effect of the GCP.

To accurately estimate the impact of the GCP, we control for several time-varying firm characteristics (x_{it}) that may influence innovation outcomes, including firm size ($Size$), firm age (Age), capital–labor ratio ($Dens$), leverage ratio (Lev), and current assets ($Cura$).

4.2.1 Empirical results and discussion

The DID regression results are presented in Table 4.3. For robustness, we extend the baseline model in Section 4.2 (Eq. (1)) by incorporating province fixed effects. These results are reported in columns (2), (4), and (6) of Table 4.3. Columns (1) and (2) report the estimated effects of the GCP on *TGFs*. The coefficients of the interaction term (*Treat*×*Post*) are consistently positive and statistically significant. After controlling for province fixed effects, the coefficient is 0.00461 (column (2)), indicating that the GCP increased the overall level of green innovation among Chinese industrial enterprises by approximately 0.46%.

Furthermore, the results reveal heterogeneous effects across different types of green patents. Columns (3) and (4) present estimates for *GIs*, showing that the coefficients of *Treat*×*Post* are statistically insignificant. This suggests that the GCP did not significantly promote green invention patent filings in GCP-restricted industries.

In contrast, columns (5) and (6) report the impact of the GCP on *GUFs*. The coefficients are positive and statistically significant, indicating that the policy had a notable effect on this type of innovation. Specifically, following the implementation of the GCP, green utility model patent filings in restricted industries increased by approximately 0.35% (column (6)).

Table 4.3 Impact of GCP on green innovation in China

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	lnTotal	lnTotal	lnInven	lnInven	lnUtim	lnUtim
Treat	-0.00330 (0.00472)	-0.00330 (0.00472)	0.00150 (0.00348)	0.00148 (0.00348)	-0.00473 (0.00315)	-0.00472 (0.00315)
Treat×Post	0.00459** (0.00233)	0.00461** (0.00233)	0.00182 (0.00153)	0.00184 (0.00153)	0.00352** (0.00178)	0.00353** (0.00178)
Post	0.02720*** (0.00084)	0.02720** * (0.00085)	0.01770** * (0.00067)	0.01770** * (0.00068)	0.01540** * (0.00060)	0.01540** * (0.00060)
Size	0.00258*** (0.00037)	0.00258** * (0.00037)	0.00124** * (0.00029)	0.00125** * (0.00029)	0.00181** * (0.00028)	0.00181** * (0.00028)
Lev	0.00097* (0.00056)	0.00097* (0.00056)	0.00101** (0.00040)	0.00101** (0.00040)	0.00062 (0.00042)	0.00062 (0.00042)

Cura	0.00166*** (0.00023)	0.00166** * (0.00023)	0.00077** * (0.00017)	0.00077** * (0.00017)	0.00118** * (0.00017)	0.00118** * (0.00017)
Age	-0.00166** (0.00077)	-0.00168** (0.00077)	-0.00115* (0.00063)	-0.00118* (0.00063)	- 0.00149** (0.00058)	- 0.00149** (0.00058)
Dens	0.00225*** (0.00019)	0.00225** * (0.00019)	0.00140** * (0.00014)	0.00140** * (0.00014)	0.00144** * (0.00014)	0.00144** * (0.00014)
Constant	-0.07020*** (0.00567)	-0.0696*** (0.01060)	- 0.0328*** (0.00325)	- 0.0261*** (0.00747)	- 0.0497*** (0.00487)	- 0.0538*** (0.00797)
Industry F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Province F.E.	No	Yes	No	Yes	No	Yes
Observations	2795960	2795960	2795960	2795960	2795960	2795960

Notes: Robust standard errors clustered at the firm level are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

To summarize, the GCP promotes the quantity of green innovation in GCP-restricted industries but does not enhance its quality. This finding is consistent with Wang and Wang (2021). It suggests that the increase in green innovation induced by the GCP may reflect firms' strategic responses aimed at reducing environmental compliance costs (Maxwell and Decker, 2006), rather than genuine technological advancement.

In other words, the GCP appears insufficient to stimulate substantive green innovation. One plausible explanation is that meaningful green innovations—particularly breakthrough technologies—requires substantial long-term investment. Due to the positive externalities associated with such innovation, private returns are often lower than social returns, which reduces firms' incentives to engage in complex and resource-intensive R&D activities (Orsato, 2006), which is characterized by more complex R&D activities.

4.2.2 Mechanism analysis

In this section, we examine the underlying mechanisms linking the GCP to firms' green innovation performance. Our analysis focuses on two key channels: agency costs and sunk costs. Specifically, the implementation of the GCP increases the cost for managers of pursuing private interests by enhancing financial institutions' supervision of corporate environmental performance, thereby helping to reduce agency costs of enterprises. Moreover, the GCP may impose tighter financial constraints on restricted firms, which can increase their sunk costs and encourage them to engage in green technological innovation.

Agency costs are known to inhibit firm-level green innovation. This channel is consistent with the findings of Acharya and Xu (2017), who argue that excessive free cash flow may increase agency costs and discourage innovation. To formally test the hypothesis that the GCP reduces agency costs, we estimate the following model:

$$Ac_{it} = \beta_0 + \beta_1 Treat_i + \beta_2 Treat_i \times Post_t + \beta_3 Post_t + \gamma x_{it} + \alpha_t + \theta_i + \varepsilon_{i,t} \quad (1)$$

where Ac_{it} represents the agency costs of firm i in year t . Following common practice in the literature (e.g., Du, 2013; Ang et al., 2000), we measure agency costs using the expense ratio, defined as the ratio of management expenses to revenue. A higher value of Ac indicates more severe principal-agent problems. In addition, we control for province, year, and industry fixed effects. The definitions of the remaining variables are consistent with those in Eq. (1).

Table 4.4 reports the regression results. Columns (1) and (2) show that the coefficient of $Treat \times Post$ is significantly negative, indicating that the GCP significantly reduces agency costs. This effect may operate through two main channels. First, the GCP internalizes the environmental externalities generated by firms into their operating costs, thereby motivating managers to pursue green innovation. Second, the policy strengthens the supervisory role of financial institutions, which helps to alleviate information asymmetry between principals and agents (Wang and Wang, 2021). As a result, agency costs decline significantly following the implementation of the GCP. These findings confirm that the GCP promotes green innovation partly by reducing agency costs.

We also examine the mediating role of sunk costs in the relationship between GCP and green innovation. The relevant results are presented in columns (3) and (4) of Table 4.4. The

coefficient of *Treat*×*Post* is significantly negative, indicating that the GCP reduces depreciation (*Depr*). This suggests that the policy increases firms' sunk costs in restricted industries. Similar findings are reported by Hu et al (2021).

A plausible explanation is that the GCP increases the risk of production curtailment or relocation, thereby raising firms' sunk costs (Qi et al., 2018). Faced with higher exit costs, firms are more likely to invest in green innovation not only by reducing agency costs but also by increasing sunk costs.

Table 4.4 Mechanisms analysis: Agency costs and sunk costs

<i>Variables</i>	Mechanisms analysis: Agency costs		Mechanisms analysis: Sunk costs	
	(1)	(2)	(3)	(4)
	<i>Ac</i>	<i>Ac</i>	<i>Depr</i>	<i>Depr</i>
<i>Treat</i>	0.00472* (0.00286)	0.00261 (0.00372)	0.00119 (0.00246)	-0.00084 (0.00334)
<i>Treat</i> × <i>Post</i>	-0.00693*** (0.00102)	-0.00652*** (0.00101)	-0.00808*** (0.00096)	-0.00796*** (0.00097)
<i>Post</i>	0.00468*** (0.00085)	0.00611*** (0.00060)	0.03430*** (0.00035)	0.0345*** (0.00037)
<i>Size</i>	-0.00101 (0.00064)	-0.00129*** (0.00035)	-0.00358*** (0.00026)	-0.00367*** (0.00027)
<i>Lev</i>	0.00322*** (0.00048)	0.00463*** (0.00039)	-0.00429*** (0.00044)	-0.00417*** (0.00044)
<i>Cura</i>	0.00045 (0.00043)	-0.00185*** (0.00024)	0.00824*** (0.00019)	0.00817*** (0.00019)
<i>Age</i>	0.00048 (0.00082)	0.00097** (0.00043)	0.00086* (0.00047)	0.00105** (0.00047)
<i>Dens</i>	0.00384*** (0.00031)	0.00264*** (0.00017)	-0.01760*** (0.00012)	-0.01760*** (0.00012)
<i>Constant</i>	0.03680*** (0.01070)	0.07800*** (0.00899)	0.23000*** (0.00220)	0.21900*** (0.00570)
<i>Industry F.E.</i>	No	Yes	No	Yes
<i>Year F.E.</i>	Yes	Yes	Yes	Yes
<i>Province F.E.</i>	Yes	Yes	Yes	Yes

<i>Observations</i>	2826718	2791585	1848976	1825716
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Notes: Robust standard errors clustered at the firm level are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

4.2.3 Empirical findings and implications

As an important financial instrument for environmental protection, green finance inevitably influences corporate environmental decision-making. Using China as a case study, this study investigates the impact of the GCP on corporate green innovation. Specifically, we employ firm-level data from the Annual Survey of Industrial Firms and conduct a DID analysis, treating the 2012 Guidelines as a quasi-natural experiment. We analyze both the quantity and quality of green innovation and further explore the underlying mechanisms in terms of agency costs and sunk costs.

The main results show that the GCP significantly promotes the quantity, but not the quality, of green innovation output among firms in GCP-restricted industries. The mechanism analysis further reveals that the GCP incentivizes green innovation by reducing agency costs and increasing sunk costs.

These findings lead to several important policy implications. First, governments should continue to improve the green credit system and strengthen the incentive effect of green finance on corporate green innovation. In particular, regulatory authorities should enhance supervision over green credit issuance by financial institutions. For example, they can establish more standardized green credit guidelines and develop a transparent information-sharing mechanism among governments, banks, and enterprises.

Second, banks should strengthen green credit management in terms of business processes and financial products. On the one hand, banking institutions can optimize credit approval procedures and improve the efficiency of enterprise credit evaluation. This would help alleviate information asymmetry and improve credit allocation for green enterprises. On the other hand, banks should intensify the assessment of environmental and social risks in credit evaluation, thereby increasing the threshold and cost for polluting enterprises to access credit. Furthermore, banks should emphasize the role of public supervision by establishing multi-channel complaint and reporting platforms to encourage public monitoring of corporate environmental performance. This can help reduce banks' information collection costs.

Third, firms — especially those in GCP-restricted industries—should increase investment in environmental governance and green technology R&D. Under the external constraints imposed by the GCP, green innovation and transformation represent optimal development strategies. Green innovation not only facilitates access to credit resources but also enhances clean production capacity and market competitiveness.

4.3 Challenges and the Way Forward for CAREC countries

4.3.1 Adaptability assessment of China’s green finance experience

(1) Policy framework construction. China has clarified green finance standards and incentive mechanisms through top-level policy documents such as the Green Credit Guidelines. This “top-level design first” approach offers direct implications for CAREC countries. However, these countries face challenges including weak policy implementation and insufficient cross-departmental coordination. For example, although Kazakhstan has issued a National Plan for Green Economic Transition, the energy, finance, and environmental departments lack a unified coordination mechanism for green project approval. As a result, policy implementation efficiency is significantly lower than in China.

Furthermore, China's “central–local” policy linkage model (such as provincial green finance index assessments) is difficult to replicate directly. Many CAREC countries operate under federal systems or grant significant regional autonomy. In addition, local governments often have limited fiscal capacity, making it difficult for them to assume responsibility for supporting green project financing.

(2) Green credit tools. China’s green credit system encourages banks to support green projects through differentiated credit pricing and preferential risk weightings. This approach directly addresses the low willingness of local banks to engage in green lending. However, the banking systems in many CAREC countries suffer from structural weaknesses, such as low capital adequacy ratios (below 8% in some cases) and high non-performing loan ratios (averaging over 10%). These indicators lag significantly behind those of China's banking sector, where capital adequacy ratios exceed 14%, making China’s “high-leverage support for green projects” model difficult to apply directly.

Furthermore, CAREC countries lack a mature corporate environmental information disclosure system similar to China’s. As a result, banks face difficulties in assessing project risks using

environmental impact assessments and green patent data, which further exacerbates information asymmetry.

(3) Risk mitigation mechanisms. China’s diversified risk management approach—combining government-backed financing guarantee funds with innovative green insurance products (such as photovoltaic module failure insurance)—offers valuable insights for CAREC countries, which face shortages of insurance and guarantee instruments. However, these countries are constrained by small domestic insurance markets and limited participation by multinational insurers. For example, green insurance products account for less than 1% of Uzbekistan’s insurance market. Furthermore, CAREC countries lack reinsurance support mechanisms comparable to those in China. The China Export and Credit Insurance Corporation provides reinsurance coverage for cross-border green projects, significantly enhancing risk protection. The absence of similar institutions in CAREC countries creates a substantial gap in risk mitigation capacity.

(4) Market player development. China has promoted green R&D investment through a combination of fiscal subsidies and tax incentives. This strategy of integrating market-based incentives with policy constraints is relevant to addressing the weak motivation for green innovation among enterprises in CAREC countries. However, firms in these countries are predominantly small, medium, and micro enterprises (accounting for over 90% of all firms) and are mainly concentrated in traditional sectors such as energy extraction and agriculture. This structure differs from China’s model, in which large industrial enterprises play a leading role in green innovation. For example, agricultural enterprises account for approximately 60% of firms in Tajikistan. These enterprises generally lack the R&D capacity and financial reserves of Chinese industrial enterprises, making it difficult for them to access green credit through mechanisms such as green patent applications.

4.3.2 Roadmap design for green finance development in CAREC countries

I. Short-term plan (1–3 years): Policy foundations and pilot breakthroughs— Addressing the lack of standards and funding shortages

Drawing on China’s Green Industry Guidance Catalogue, policymakers should develop regionally adapted standards based on the resource endowments of CAREC countries. For example, cross-border hydropower, solar irrigation, and low-carbon transformation of oil and

gas extraction could be listed as core green project types. At the same time, under the CAREC mechanism, a cross-border green project certification platform should be established to promote mutual recognition of standards among countries such as Kazakhstan and Kyrgyzstan, thereby removing barriers to cross-border green capital flows. In addition, drawing on China's "government guarantee + insurance linkage" mechanism, CAREC governments are encouraged to jointly establish a Regional Green Guarantee Fund to provide risk-sharing support for local banks' green lending.

II. Mid-term tasks (3–5 years): Market cultivation and capacity building—Addressing weak financing capacity and limited intermediary services

A Green Project Rapid Assessment Model should be developed for national banks in CAREC countries, replacing complex carbon-reduction quantification models with simplified criteria based on project type, collateral value, and government subsidy commitments. Furthermore, a green credit capacity-building program should be promoted among CAREC countries. In particular, the Industrial and Commercial Bank of China and the Bank of China could provide technical training to central and commercial banks in Kazakhstan, Kyrgyzstan, and other countries. This initiative would help improving risk pricing for green projects and enhance environmental information collection capabilities. Additionally, in line with the energy-export orientation of many CAREC countries and drawing on China's experience in green bond markets, entities such as Kazakhstan's national oil company should be encouraged to issue RMB- or ruble-denominated cross-border green energy bonds to support the low-carbon transformation of oil and gas production.

III. Long-term goals (5–10 years): Regional coordination and international integration—Building a sustainable and adaptive green financial ecosystem

In the long term, CAREC countries are encouraged to establish a Green Finance Coordination Committee, composed of representatives from finance ministries, central banks, and environmental authorities. This committee would be responsible for developing unified regional green project standards, cross-border risk-sharing mechanisms, and information-sharing platforms. In addition, a CAREC Green Project Database could be established to integrate environmental impact assessment reports, financing needs, and risk-level information from participating countries, thereby reducing information asymmetry in cross-border projects.

Furthermore, governments should deepen China–CAREC cooperation in green finance. By leveraging the BRI Alliance for Green Development, a China–CAREC Green Finance Cooperation Platform could be established, focusing on three key areas: standard alignment, technology transfer, and talent exchange. For example, a China–CAREC Green Finance Talent Training Program could be launched to annually send financial regulators and bank executives from CAREC countries to institutions such as the People’s Bank of China and the China Development Bank for professional training.

5. Conclusions and policy implications

5.1 Conclusions

Green finance mechanisms, such as green bonds, climate funds, and PPPs, are instrumental in supporting the green transition in CAREC countries. Given the significant financing gap (estimated to exceed USD 400 billion by 2030), reliance on public funds alone is insufficient, making it necessary to mobilize private sector capital for long-term sustainable development. Furthermore, MDBs, such as the ADB, EBRD, and World Bank, have played a significant role in supporting green finance in CAREC countries. The establishment of effective regulatory frameworks for green finance largely depends on their investments in energy and climate projects, as well as their technical assistance and policy recommendations. In addition, the PPP model is gaining increasing recognition as an effective approach to financing green infrastructure projects. In the CAREC region, PPPs have become a key tool for scaling up waste management facilities, energy-efficient transportation systems, and renewable energy projects. These partnerships help alleviate financial pressure on the public sector while leveraging the expertise and experience of the private sector. However, despite some progress in green finance development, institutional bottlenecks, insufficient project preparation funds, a lack of risk mitigation tools, and limited domestic financing capacity continue to constrain the effective mobilization of green finance. These challenges must be addressed to fully unlock the development potential of green finance in the region.

5.2 Policy implications

Based on the above findings, the following policy implications can be drawn.

First, CAREC member governments should establish a unified green finance regulatory framework and formulate transparent rules for green bonds and climate funds. Each country

should introduce a regionally harmonized green project classification standard and clarify the scope of green project eligibility. Furthermore, relevant departments should streamline green project approval procedures and establish dedicated PPP management agencies to provide institutional support. Governments can attract private capital through incentives such as tax breaks and fiscal subsidies and by innovatively developing green bonds and hybrid financing instruments. In addition, a regular public–private dialogue mechanism should be established to jointly assess the investment risks of green infrastructure projects.

Second, CAREC countries should strengthen regional collaborative capacity building and organize training programs for government officials on the operation and management of green PPP projects. A platform for member countries to exchange experiences and share best practices in green finance should be developed. Countries should actively promote regional green finance markets to broaden financing channels and reduce investment risks. Moreover, international organizations and MDBs should increase support for vulnerable countries by expanding climate finance quotas and providing concessional loans.

Third, CAREC countries are encouraged to collaborate with multilateral institutions to develop risk mitigation tools and reduce private investment risks through guarantee and insurance mechanisms. Local banks should also be supported in developing specialized green finance products tailored to infrastructure project needs. In addition, countries can jointly promote cross-border renewable energy cooperation projects and establish regional green finance centers to pool financial resources and professional expertise.

Appendix A: The role of green finance in green transition in CAREC countries

Green finance plays a key role in accelerating green transition in CAREC countries. As these countries strive toward low-carbon and climate-resilient development pathways, the availability and mobilization of sustainable financial resources have become increasingly critical.

As the region faces rising energy demand, environmental degradation, and growing climate vulnerability, green finance is essential for supporting investments in renewable energy, climate-resilient infrastructure, energy efficiency, and sustainable agriculture.

According to the ADB, CAREC countries will require more than USD 400 billion in green investments by 2030 to achieve their climate targets and meet the commitments of the Paris Agreement. However, public budgets alone are insufficient to close this financing gap. Therefore, mobilizing private capital through green bonds, climate funds, blended finance mechanisms, and other innovative financing models is necessary.

A1. Importance of Green Finance in CAREC Countries

Although CAREC countries differ in their economic structures and development stages, they all share an urgent need for green investment. Below is an overview of how green finance supports the green transition in each country.

Afghanistan: Highly vulnerable to drought and water scarcity, Afghanistan requires green finance to support climate-resilient agriculture and off-grid solar solutions. However, ongoing conflict and institutional weaknesses hinder access to international finance. Current support is mainly limited to small-scale initiatives by the ADB and the UNDP.

Azerbaijan: As a major fossil fuel exporter, Azerbaijan faces significant challenges in decarbonizing its economy. Green finance has been used to support the development of solar and wind energy. In 2022, the country launched a 230 MW solar PPP project in partnership with Masdar, supported by international climate finance.

Georgia: While largely reliant on hydropower, Georgia needs green finance to diversify into solar and wind energy, particularly in light of climate-related fluctuations in water availability. The Green Climate Fund (GCF) has provided USD 70 million to support energy-efficient housing and agricultural development.

Kazakhstan: As the region's largest greenhouse gas emitter, Kazakhstan aims to increase the share of renewables to 15% by 2030 and achieve carbon neutrality by 2060. Green finance supports major renewable projects, such as the Zhanatas 100 MW wind farm, backed by the EBRD and the GCF. Kazakhstan issued its first green bond in 2020 and is developing a national green taxonomy.

Kyrgyz Republic: With a relatively clean energy mix based on hydropower, Kyrgyzstan requires green finance for grid modernization and climate-resilient agriculture. MDBs are investing in energy efficiency and public infrastructure upgrades.

Mongolia: Highly dependent on coal and exposed to extreme weather conditions, Mongolia has issued a sovereign green bond to fund clean heating systems, solar energy projects, and electric buses. The GCF and other partners support green housing programs in Ulaanbaatar's informal settlements.

Pakistan: Facing increasing climate risks, including floods and heatwaves, Pakistan has attracted over USD 800 million in climate finance. These funds support renewable energy projects, climate-smart infrastructure, and energy efficiency programs. The government is also developing a green finance taxonomy to guide future investments.

People's Republic of China (Xinjiang and Inner Mongolia): These western regions are key to China's broader green strategy, with large-scale investments in wind, solar, and green hydrogen. Green finance also supports transboundary projects under the BRI that benefit neighboring CAREC countries.

Tajikistan: Dependent on hydropower and vulnerable to climate-induced water shortages, Tajikistan uses green finance to rehabilitate dams, improve irrigation systems, and strengthen infrastructure resilience. It receives support from the GCF and the Climate Investment Funds (CIF).

Turkmenistan: As one of the most greenhouse gas-intensive economies in the region, Turkmenistan has considerable potential for solar energy development and methane emission reduction in the gas sector. While green finance activity remains limited, MDBs are working to develop enabling policies and pilot projects.

Uzbekistan: A regional leader in green transition, Uzbekistan aims to achieve 12 GW of renewable capacity by 2030. It issued its first sovereign green bond in 2023 and is

implementing multiple renewable energy PPP projects with support from the ADB, EBRD, and International Finance Corporation (IFC).

A2. Growth of Green Finance Instruments

Among green financial instruments, green bonds and climate funds have experienced the most significant development in the CAREC region. Kazakhstan became the first CAREC country to issue green bonds in 2020, raising more than USD 20 million for renewable energy projects. Uzbekistan and Georgia have followed this example. Uzbekistan's first sovereign green bond, issued in 2023, attracted widespread attention from international investors. In terms of climate funds, the Green Climate Fund has approved projects in several CAREC countries, including Mongolia's energy-efficient housing program and Uzbekistan's solar photovoltaic infrastructure project.

A3. Role of Multilateral Development Banks (MDBs)

Green finance in the CAREC region has received strong support from MDBs, particularly the World Bank, the ADB, and the EBRD. From 2015 to 2022, the ADB pledged more than USD 2.3 billion for green energy and climate-related projects in CAREC countries, while the EBRD invested more than EUR 1.1 billion in sustainable energy projects in Central Asia, with a focus on wind, solar, and green hydrogen. In addition to financial support, MDBs assist governments in formulating green finance strategies and regulatory frameworks by providing technical assistance, capacity-building programs, and policy advice.

A4. Role of Public-Private Partnerships (PPPs)

PPPs are becoming a key mechanism for financing and implementing green infrastructure projects in CAREC countries. Given limited public budgets and fiscal space, PPPs offer a viable solution for mobilizing private capital, technical expertise, and innovation to promote sustainable development.

A4.1 Unlocking Private Capital for Green Projects

Governments can use PPPs as an important tool to attract long-term private investment in sustainable infrastructure projects, such as waste-to-energy facilities, energy-efficient transportation systems, renewable energy plants, and smart water management projects. This model helps reduce the financial burden on the public sector and improves project financing efficiency, which is essential for green development. The Navoi 100 MW solar power project

in Uzbekistan is a representative example. Supported by the IFC and the ADB, it is the country's first large-scale solar PPP project. The project was awarded to Masdar through competitive bidding and achieved a record-low electricity price of USD 0.0267 per kilowatt-hour, demonstrating the cost-effectiveness of a well-structured green PPP model. Kazakhstan has also actively implemented PPP projects in solar and wind energy, supported by sovereign guarantees and electricity price stabilization mechanisms. The Zhanatas 100 MW wind farm is a successful case, using global climate finance to attract private sector participation and jointly funded by the EBRD and the Green Climate Fund.

A4.2 Strengthening Risk Sharing and Innovation

One of the major advantages of the PPP model is its ability to allocate risks effectively between the public and private sectors. Typically, private partners assume construction, operational, and certain market risks, while governments bear political and regulatory risks. This shared responsibility mechanism lowers entry barriers for private investors and helps ensure that projects are completed on time and within budget.

Moreover, private sector partners often introduce performance-based management practices, efficiency-enhancing methods, and technological innovations, which are essential for sustainable infrastructure development. For example, the Mongolian Green Building Project adopted smart heating systems and advanced insulation materials through a PPP arrangement, significantly reducing emissions during harsh winter conditions.

A4.3 Institutional Support and Capacity Building

MDBs provide institutional support to CAREC countries to promote the use of PPPs in green sectors, including the development of standardized contracts, procurement guidelines, and legal frameworks for PPP implementation. The ADB offers transaction advisory services for renewable energy tenders and assists countries such as Georgia and Azerbaijan in establishing dedicated PPP institutions.

At the same time, capacity-building initiatives by development partners help local authorities acquire essential skills in performance monitoring, environmental risk assessment, and green PPP project design.

A4.4 Sectoral Opportunities for Green PPPs

There is significant potential to expand PPP-based green investments in the following sectors across CAREC countries:

- (1) Renewable energy: Battery storage systems, wind, solar, and small hydropower projects.
- (2) Green transportation: Low-carbon logistics systems, light rail transit, and electric bus networks.
- (3) Water and sanitation: smart metering, wastewater reuse systems, and energy-efficient desalination facilities.
- (4) Waste management: Waste-to-energy plants, landfill gas recovery systems, and recycling facilities.
- (5) Green buildings: Energy-efficient public housing and educational facilities.

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