DECARBONIZATION OF ENERGY IN CENTRAL ASIA

OECD Sustainable Infrastructure Programme in Asia (SIPA)

Dr. Ablay Dosmaganbetov[1], Nagima Shukurbekova[2], Gulrukhsor Vanjieva[3]

[1] Research Fellow in Data Analytics, Institute of Public Policy and Administration, Graduate School of Development, University of Central Asia
[2] Research Associate, Institute of Public Policy and Administration, Graduate School of Development, University of Central Asia
[3] Research Assistant, Institute of Public Policy and Administration, Graduate School of Development, University of Central Asia

Bishkek, Kyrgyz Republic
September, 2, 2025

Contents

List of abbreviations and key terms

CA: Central Asia, includes Kazakhstan, Kyrgyzstan, Mongolia, Tajikistan, Turkmenistan and Uzbekistan

Carbon-intensive infrastructure projects: projects that include investments from both national and international agencies in traditional energy sources such as oil, natural gas, and coal.

Energy efficiency infrastructure projects: projects aimed to increase energy efficiency in different types of units, such as public buildings, residential buildings, industrial enterprises, lighting, electricity transmission and district heating.

ESG: Environmental, Social, Governance

ETS: Emissions Trading Scheme

EV: Electric Vehicle

GHG: Greenhouse Gas

GWh: Gigawatt hour

MW: Megawatt

LNG: Liquid Natural Gas

Low-carbon infrastructure projects: projects that include investments from both national and international agencies in renewable energy sources such as solar, wind, hydro, and their mix. Such projects also consider investments in energy efficiency, optimization, and other fields.

NDC: Nationally Determined Contribution

NGO: Non-governmental organization

PPP: Public-private partnership

Renewable energy projects: projects aimed to generate and supply energy from such sources as solar power plants, wind power plants, hydropower plants and their mix.

RE: Renewable Energy

SDGs: Sustainable Development Goals

SOE: State-owned enterprise

UN: United Nations

UNFCC: United Nations Framework Convention on Climate Change

Abstract

This paper examines the progress of Central Asian countries in reducing CO_2 emissions within the energy sector by analyzing investment trends in carbon-intensive and low-carbon energy infrastructure from 2008 to 2023, inclusive. The study highlights that while carbon-intensive energy infrastructure remains significant in the region, there is a growing potential for low-carbon projects. The research covers an analysis of investment patterns across six Central Asian countries, identifying key energy policies and the evolving landscape of energy infrastructure development. The paper also considers major challenges and opportunities for energy decarbonization. It concludes with some policy recommendations tailored to each country's context, which could help make meaningful progress towards energy decarbonization in Central Asia.

1. Introduction

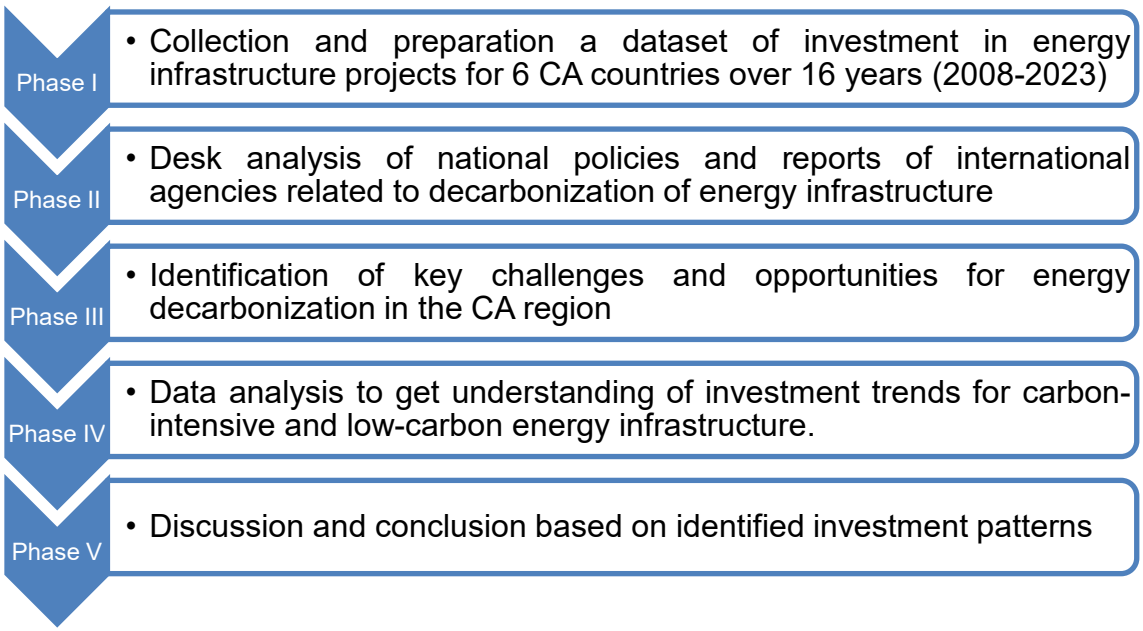
This paper evaluates the policy landscape in CA by analyzing a dataset of the energy sector decarbonizing projects, to assess how current measures are effective in advancing a more sustainable energy future. The study contributes to the implementation of the OECD Sustainable Infrastructure Programme in Asia (SIPA), sponsored by the government of Germany through its International Climate Initiative (IKI). SIPA's primary objective is to support Central and Southeast Asia nations with the alignment of their energy, transport, and industrial infrastructure investments with low-emission development pathways. This alignment is critical to ensuring compatibility with both the Paris Agreement and the Sustainable Development Goals (SDGs), promoting long-term sustainability and climate resilience across the region.

The CA has been witnessing increasing levels of CO_2 emissions due to its dependence on fossil fuels, especially coal, oil, and gas, to meet its growing energy demands. Other factors that contribute to the CO_2 emissions in the region are the extensive energy intensity of infrastructure, which is outdated and requires investments for upgrades. The region's industrialization and economic growth have led to a surge in GHG emissions, exacerbating climate and broader environmental issues such as air, water, and soil pollution, and social impacts such as impacts on public health, life expectancy, etc. At the same time, this energy-heavy development model has heightened the need for sustainable solutions, driving interest in decarbonization strategies to reduce the environmental footprint of these economies. Countries recognize the need to transition to sustainable growth pathways, with tackling climate change becoming a key priority in the region, driven by commitments to the Paris Agreement.

2. Data and methodology

The study focuses on six CA countries: Kazakhstan, Uzbekistan, Kyrgyzstan, Tajikistan, Turkmenistan, and Mongolia. The comprehensive research approach uses combined policy reviews and quantitative analysis of investment data (Figure 1). The workflow included data collection from publicly available sources, including websites of the governments (national government/authorities' websites) and international financial institutions (Central Asian Regional Economic Cooperation (CAREC) Institute, Asian Development Bank (ADB) project websites, Eurasian Development Bank (EDB) report, etc.).

Figure 1. The study workflow



Source: authors' own development

The dataset was developed and used to assess the current state and identify trends in project financing and policymaking efforts aimed at decarbonizing the energy sector in CA. The investment dataset spans 16 years (2008-2023) and includes both carbon-intensive and low-carbon energy infrastructure projects, enabling comparisons and trend analysis for both types of energy infrastructure. The project dataset includes information about funding sources (e.g., public financing, international financial institutions, international organizations), project status (e.g., ongoing, completed, or canceled), funding volume (in millions of US dollars), funding type (e.g., loan, grant, or technical assistance or their combination), and energy cluster (e.g., oil, gas, coal, energy efficiency, RE infrastructure and others). The unit of data (analysis) is an individual project. The currency used is the United States Dollar (USD).

The dataset includes identified projects in both carbon-intensive and low-carbon energy infrastructure which are classified into several clusters such as:

Carbon-intensive energy infrastructure projects

- *Coal*: extraction, transportation, and processing; coal plant upgrades; and coal-fired power plants
- *Gas*: line projects; power plants; transition from coal to gas; and LNG production
- *Oil*: exploration; extraction; production; and transportation

Low-carbon energy infrastructure projects

- *Energy-efficiency*: public buildings; residential buildings; industrial enterprises; lighting; electricity transmission; and district heating.
- *Renewable energy*: solar power plants; wind power plants; hydropower power plants; and their mix
- *Other*: modernization of energy equipment, grid optimization, etc.

A key limitation of the methodology is the incomplete investment data for certain countries, most notably Turkmenistan, but also to a lesser extent Tajikistan and parts of Uzbekistan, where available records are sporadic or lack detailed sectoral disaggregation. While Turkmenistan is included in the database and appears in the investment trend section, data coverage is partial, particularly for the earlier years of the period studied. We estimate that the database captures approximately 75–85% of total investments in the region, based on cross-validation with publicly available project listings, national government reports, and publications from international organizations (e.g., ADB, World Bank, UNESCAP). Given that most investments are concentrated in Kazakhstan and Uzbekistan where data coverage is more complete, we assess that the missing data is unlikely to significantly distort the overall regional trends. Nevertheless, findings for Turkmenistan and Tajikistan should be interpreted with caution due to these data constraints.

Another important caveat is the variation in natural resource endowments across countries, which affects the structure and comparability of energy infrastructure investments. For instance, Kazakhstan has attracted significant investment in oil infrastructure, while Turkmenistan has seen more investment in gas-related infrastructure, both of which contribute to carbon-intensive energy systems. This makes direct comparisons between countries challenging. Conversely, Kyrgyzstan and Tajikistan rely heavily on hydropower as their primary renewable energy source, which has shaped their investment patterns toward low-carbon infrastructure more prominently than in other Central Asian states.

3. Policy environment on energy decarbonization in Central Asia

This section offers an overview and brief description of key policy documents related to energy decarbonization in each CA country, as summarized in Appendix 1, which highlights the main national policies on energy and energy decarbonization across the region. In general, most CA nations have pledged substantial GHG reductions through their NDCs and long-term development plans. These commitments reflect not only the urgency of addressing climate change but also the broader effort to transition towards sustainable, low-carbon economies. However, the successful implementation of these targets is highly dependent on international cooperation, including access to cutting-edge technology, capacity building, and financial assistance from global climate funds and development partners. The transition toward low-carbon energy systems in CA is complex, requiring significant shifts in energy and climate mitigation policy, investment in RE sources, and technological innovation. CA governments have translated their climate commitments into ambitious measures with carbon emission reduction potential into their national development strategies (Table 1), mainstreaming climate goals both into their national agendas and their global climate commitments.

Efforts to reduce CO_2 emissions in CA have gained momentum as countries in the region work to align their policies with global climate and sustainability commitments, including the Paris Agreement and the United Nations Agenda 2030 for Sustainable Development. The Paris Agreement, adopted in 2015, commits signatory nations to limiting global temperature rise to below 2°C, with an aspirational goal of 1.5°C, by reducing GHG emissions. CA countries, as signatories, are making efforts to transition towards greener, less carbon-intensive energy systems while also delivering objectives to economic growth.

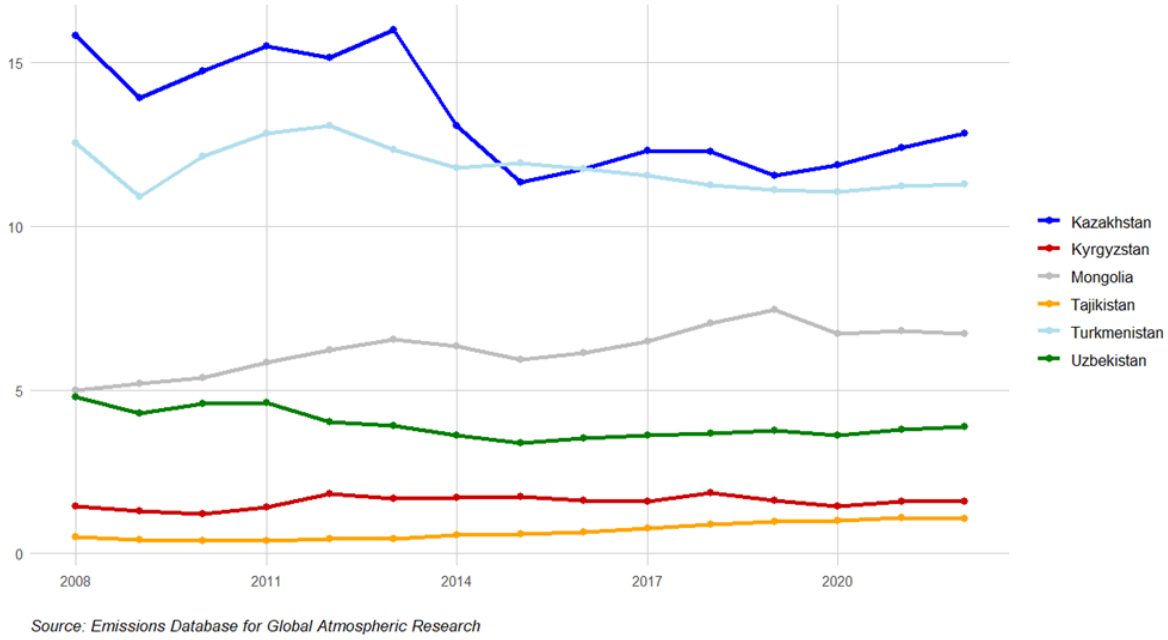
Table 1. Key policy documents for energy decarbonization in Central Asia

Country	Name of the policy document
Kazakhstan	Sustainable Industrial Transformation Strategy (2024)
	Energy Ministry's Renewable Energy Program (2020)
	Nationally Determined Contribution (2022)
Kyrgyzstan	Implementation of Energy Conservation and Energy Efficiency Policy in the Kyrgyz Republic for 2023-2027
	Program for the Development of the Green Economy in the Kyrgyz Republic for 2019-2023
	Updated Nationally Determined Contribution (2021)
Mongolia	Law of Mongolia on Energy (2015)
	Nationally Determined Contribution (2020-2030)
	Mongolia’s Vision 2050 (2020)
Tajikistan	Energy Efficiency Master Plan (2011)
	Power Sector Development Master Plan Final Report (2017)
	Nationally Determined Contribution (2021)
Turkmenistan	Renewable Energy Law (2020)
	Nationally Determined Contribution (2021)
	Gas-to-Liquids (GTL) Technology Investment Initiative (2014)
Uzbekistan	Law of the Republic of Uzbekistan on the Utilization of Renewable Energy Sources (2019)
	Presidential Decree on Measures to Increase the Efficiency of Reforms Aimed at Transitioning the Republic of Uzbekistan to a Green Economy by 2030 (2022)
	Updated Nationally Determined Contribution (2021)

Source: based on the collection and analysis of the main policy documents.

The UN's Agenda 2030, meanwhile, highlights the importance of sustainable energy under its SDGs (SDG 7), which means that the decarbonization agenda is critical for the country and regional progress towards affordable, reliable, sustainable, and modern energy for all. CO_2 emissions per capita in CA have remained relatively stable over the past 16 years, with significant variation across different countries (Figure 2). Although countries have followed different emission trajectories, their per capita CO_2 levels in 2023 remain largely unchanged compared to 2008.

Figure 2. CA country energy dynamics, CO_2 emissions, tons per capita



Source: Emissions Database for Global Atmospheric Research

3.1. Kazakhstan

The ***Sustainable Industrial Transformation Strategy (2024)*** for Kazakhstan focuses on sector-specific decarbonization while balancing economic growth and environmental sustainability. It establishes dual investment tracks: one for scaling low-carbon energy (targeting 50% RE in electricity generation by 2050, up from 3% in 2022), and another for decarbonizing carbon-intensive industries (aiming for a 20% reduction in industrial emissions by 2035 through carbon capture, energy efficiency, and methane reduction). The strategy strengthens Kazakhstan's ETS by setting a progressive carbon price of 15–30 USD per ton CO_2 by 2030 and introduces green tax reforms, incentivizing businesses to cut emissions. It enhances green finance mechanisms, aiming to mobilize 10 billion USD in sustainable investments by 2035, including transition finance and ESG-aligned funding. Additionally, it promotes regional economic diversification, targeting 50,000 new green jobs and supporting the transformation of coal-dependent regions into clean energy and industrial hubs.

Kazakhstan's ***Renewable Energy Program (2020)***, developed by the Ministry of Energy, outlines the nation's roadmap for expanding RE capacity and diversifying its energy sources. The program is a response to Kazakhstan's commitment to reduce its carbon footprint and increase the share of clean energy in its energy mix. It targets substantial growth in RE capacity, with specific milestones to reach 15% RE in the total energy mix by 2030 and 50% by 2050. This program supports Kazakhstan's commitments under the Paris Agreement to

reduce GHG emissions by gradually transitioning to lower-carbon energy sources, including renewables and cleaner alternatives to coal.

Kazakhstan's ***Nationally Determined Contribution (NDC)*** reflects its commitment under the Paris Agreement to combat climate change by reducing GHG emissions, particularly focusing on the energy sector. The NDC outlines specific targets for emissions reductions, aiming for a 15% reduction from 1990 levels by 2030, with a conditional target of up to a 25% reduction pending additional support. The energy sector, being the primary contributor to Kazakhstan's emissions due to heavy reliance on coal, is a central focus of these commitments, with the government aiming to gradually phase in RE sources such as wind, solar, and hydroelectric power.

3.2. Kyrgyzstan

The ***Implementation of Energy Conservation and Efficiency Policy in the Kyrgyz Republic for the 2023-2027 program*** aims to critically assess the current situation with fuel and energy resources in the country. The key priorities of the comprehensive program are enhancing energy efficiency in consumption, aiming for savings of 190.1 thousand tons of coal equivalent by 2027, and promoting the use of cleaner fuel and energy resources, including increasing the share of RE sources in electricity production to at least 10% by 2027. These priorities are aimed at enhancing the efficiency of the energy system, creating economically favorable conditions for consumers, minimizing negative environmental impacts, and ensuring the stable development of the country's energy sector.

The ***Program for the Development of the Green Economy in the Kyrgyz Republic for 2024-2028*** aims to enhance energy security and transition to low-carbon, sustainable energy through long-term energy planning, regulatory reforms, and supportive policy mechanisms. Key measures of this Program include mitigating investment risks, integrating RE sources into the energy system, building capacity in public and private sectors, and strengthening regional and international energy cooperation. The program also targets reduction of GDP energy intensity in Kyrgyzstan by 20% from 2022 levels (around 160 thousand USD) by improving resource efficiency, minimizing energy losses, and adopting advanced technologies in the residential and industrial sectors. Additionally, with urban air pollution largely driven by the growing number of internal combustion engine vehicles, the government plans to facilitate a transition to carbon neutrality in transportation by 2028, aiming for a 5% share of electric vehicles, establishing 1,000 charging stations, reducing CO_2 emissions in major cities, training 500 EV maintenance specialists, and phasing out outdated vehicles. These efforts collectively contribute to optimizing energy consumption, strengthening energy security, and improving environmental conditions in the country.

The ***Updated Nationally Determined Contribution (NDC)*** *of the Kyrgyz Republic*, aligned with key decisions of the UNFCCC and Paris Agreement, reflects a comprehensive state approach to combating climate change, coordinated by the State Committee for Ecology and Climate and endorsed by the Prime Minister-led Coordination Council. Developed through an inclusive process involving government agencies, civil society, youth, and international partners, the NDC sets ambitious targets to reduce GHG emissions. By 2025, Kyrgyzstan aims for a 17% reduction in emissions (or 37% with international support), rising to 44% by 2030, primarily through RE expansion, fossil fuel reduction, and increased energy efficiency.

Key sectors for mitigation include energy, agriculture, forestry, and land use, with targeted actions to drive low-carbon transformation.

3.3. Mongolia

Mongolia's Vision 2050 *(2020)* sets a strategic framework for transitioning towards a low-carbon and sustainable energy future while balancing economic growth and environmental responsibility. The policy acknowledges Mongolia's heavy reliance on coal but aims to diversify the energy mix by significantly increasing RE generation. The plan includes short-term (2021-2030), medium-term (2031-2040), and long-term (2041-2050) goals, focusing on reducing GHG emissions, improving energy efficiency, and integrating clean technologies into the energy sector. A key objective is to develop a national green financing system to support RE projects, enhance energy security, and promote international climate commitments such as the Paris Agreement. The policy envisions a gradual shift from coal to cleaner alternatives, including solar, wind, hydro, and green hydrogen, supported by technological advancements and investment incentives.

The ***Energy Law of Mongolia*** covers provisions to regulate energy generation, focusing on reducing carbon-intensive sources and incorporating low-carbon and renewable sources. The law defines 'energy resources' to include both fossil fuels based (carbon intensive) such coal, oil shale, fuel oil, uranium and thorium ores, biomass, organic materials, and gas and RE resources (low carbon) such as wind, solar, hydroelectric power, and geothermal energy, indicating Mongolia's intent to balance traditional energy production with sustainable alternatives. This law introduces two categories of energy supply: regulated and unregulated. The regulated energy supply refers to the sale of heat and electricity at the price approved and published by the Energy Regulatory Authority. These tariffs are determined based on operational costs, consumer classifications, and regulatory policies to ensure price stability, affordability, and energy efficiency.

Mongolia's commitment to the Paris Agreement is evident in its ***First Submission of the Nationally Determined Contribution*** (NDC), which outlines ambitious targets to cut GHG emissions by 2030. In alignment with global climate objectives, Mongolia has set a primary target to reduce emissions by 23% compared to a business-as-usual scenario, with a conditional target of 27% if advanced carbon-capture technologies are implemented. Additionally, by incorporating forest-based carbon sinks, the total reduction could reach 45%. These goals reflect Mongolia's broad commitment to transitioning to a low-carbon economy, focusing heavily on RE sources, energy efficiency, and sustainable practices across various sectors.

3.4. Tajikistan

The ***Energy Efficiency Master Plan (EEMP)*** for Tajikistan is a foundational framework aimed at modernizing energy use across the country and addressing critical seasonal shortages, particularly in winter when energy demand is high. Developed with support from the United Nations and other international partners, the EEMP identifies systemic barriers to energy efficiency, such as outdated infrastructure, high transmission losses, and insufficient regulatory enforcement. The plan seeks to address transmission and distribution losses in Tajikistan's power sector, which can reach between 18 and 20% annually by updating the grid and reducing energy leakage.

The ***Power Sector Master Plan*** includes the development of low-carbon projects, with substantial investments planned for the Rogun Hydroelectric Power Plant, expected to add 3,600 MW. This project, alongside smaller hydropower plants, aims to reduce dependency on carbon-intensive imports and coal-based generation, projected to decrease emissions by 34,173 GWh annually once operational. Coal and gas-fired plants, while still in the plan to ensure energy stability, have been allocated emissions penalties as a disincentive for continued reliance on fossil fuels. These penalties include higher carbon taxation, stricter emissions caps, and phased-out subsidies for fossil fuel production, pushing utilities and industries to shift toward cleaner alternatives. Additionally, revenue from these penalties is expected to be reinvested in RE projects, grid modernization, and energy efficiency initiatives, reinforcing Tajikistan's transition to a low-carbon economy. This policy framework signals a clear preference for renewable resources while ensuring that traditional energy sources remain a temporary fallback rather than a long-term solution.

Tajikistan's updated ***Nationally Determined Contribution (NDC)*** focuses on reducing carbon-intensive energy sources and advancing low-carbon technologies, aligned with its ambitious climate commitments under the Paris Agreement. The country's primary target is to cap GHG emissions at 60-70% of 1990 levels by 2030, with a conditional goal of 50-60% if further international support is secured. Tajikistan's reliance on hydropower, which constitutes around 92% of its current generation capacity, provides a strong foundation for low-carbon energy. However, seasonal demand peaks during winter necessitate alternative sources to meet energy requirements sustainably.

3.5. Turkmenistan

The ***Renewable Energy Law*** adopted by Turkmenistan in 2021 aims to promote the development and use of RE sources as part of the country's commitment to sustainable energy and climate action. However, this law does not specify a clear target for the share of RE in the national energy mix. This law forms a part of Turkmenistan's broader environmental and climate strategies, including the National Strategy for the Development of Renewable Energy until 2030 and the National Climate Change Strategy. These initiatives align Turkmenistan's national policies with the Paris Climate Agreement goals and the UN SDGs.

Turkmenistan's ***Nationally Determined Contribution (NDC)***, submitted in 2021, establishes a comprehensive framework for the country's approach to climate change mitigation as part of its commitment under the Paris Agreement. The NDC sets ambitious targets, aiming for a 10% reduction in GHG emissions from 2019 levels by 2030. Moreover, with international financial and technical support, Turkmenistan envisions the potential to reduce its GHG emissions in 2030 under the business-as-usual scenario by 20% compared to the level of emissions in 2010.

The ***Gas-to-Liquids (GTL) Technology Investment initiative*** in Turkmenistan from 2014 to 2019 involved substantial investments aimed at enhancing the country's energy sector by converting natural gas into high-value liquid fuels and chemicals. The goal was to create advanced GTL facilities that can process around 10 billion cubic meters of natural gas annually. During this period, Turkmenistan sought partnerships with global industry leaders, including companies like Shell and Sasol, to leverage their expertise in GTL technology. The establishment of these facilities is expected to produce approximately 1.5 million tons of liquid

hydrocarbons per year, including cleaner-burning fuels such as diesel and kerosene. This diversification of the energy portfolio is critical for the country, which aims to reduce its dependence on traditional oil exports and improve the environmental footprint of its hydrocarbon production. The volume of harmful emissions into the atmosphere, including GHG, will be reduced by 3.1 million tons annually by building a power plant at Mary Valayat with a capacity of 1,500 MW operating on a combined cycle.

3.6. Uzbekistan

The Law of the Republic of Uzbekistan on the ***Utilization of Renewable Energy Sources*** aims to provide a harmonized regulatory and policy framework by integrating different programs. policies and plans. Concerning the use of RE sources, it establishes a legislative framework that includes this law and other related regulations. If any international treaty specifies rules differing from national legislation, the treaty provisions prevail. The law defines key concepts such as “local networks”, “micro and small hydropower plants,” “green energy certificates”, and “RE sources” which include solar, wind, geothermal energy, and biomass. It outlines the main directions of state policy, including energy security, the promotion of innovative technologies, and the involvement of private enterprises in generating RE. The law also emphasizes the importance of public participation and provides rights and obligations for RE producers, aiming to create favorable conditions for investment and the adoption of renewable technologies in Uzbekistan.

The ***Presidential Decree on Measures to Increase the Efficiency of Reforms Aimed at Transitioning the Republic of Uzbekistan to a Green Economy by 2030*** outlines strategic measures for advancing the country’s green economy by 2030, as part of the ***“New Uzbekistan”*** Development Strategy (2022-2026). Key objectives include reducing GHG emissions per GDP unit by 35% from 2010 levels, expanding RE capacity to 15 GW, and increasing energy efficiency in industries by at least 20%. It also mandates the creation of regulatory frameworks for GHG emissions and energy-saving technologies, backed by a coordinated effort among various ministries, the establishment of a monitoring council, and support from international financial partners.

Based on the ***Updated Nationally Determined Contribution,*** Uzbekistan aims to enhance its climate change commitments, in line with the Paris Agreement and UNFCCC decisions. During ratification of the Paris Agreement by Uzbekistan in 2010, the country aimed for a 10% reduction in specific GHG emissions per unit of GDP by 2030. The new target aims for a 35% reduction, reflecting the country’s shift towards a resource-efficient, green development model while ensuring economic growth. The updated NDC focuses on structural reforms, energy efficiency, RE expansion, and resource-saving technologies across various sectors. This effort is supported by various stakeholders, including government ministries, academia, civil society, and the UN Development Program.

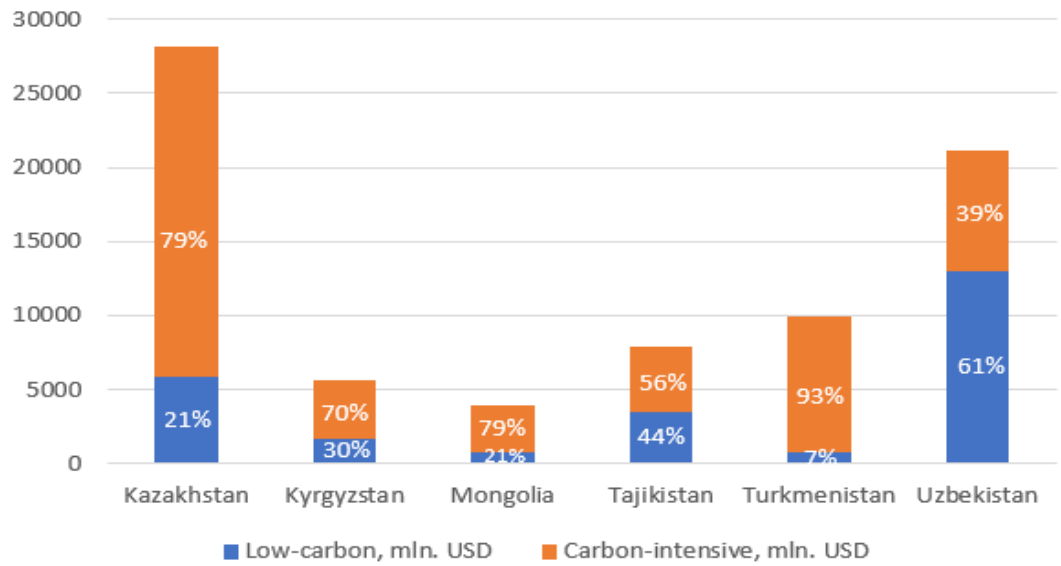
4. Investment trends in energy decarbonization in Central Asia

This section provides information and descriptions of investment trends in both carbon-intensive and low-carbon energy infrastructure projects. The different graphical representation of compiled datasets (UCA carbon-intensive and low-carbon databases) of diverse energy infrastructure projects aims to show investment patterns across six countries over 16 years.

To date, reliance on fossil fuels, notably coal and gas, remains a significant hurdle in the decarbonization efforts of Central Asia. Kazakhstan, one of the largest coal producers in the world, generates about 70% of its electricity from coal-fired power plants, while Turkmenistan and Uzbekistan are highly dependent on natural gas, a major export commodity and source of domestic energy. These fossil fuels are deeply embedded in their economies, making the transition to renewables more complicated (IEA, 2023).

Figure 3 illustrates the distribution of low-carbon and carbon-intensive energy infrastructure investments across Central Asian countries. The data shows that while Kazakhstan and Uzbekistan saw the highest levels of energy infrastructure investments between 2008 and 2023, Uzbekistan attracted the highest amounts of low-carbon investments (i.e., 61% of total energy infrastructure investments in the country). In contrast, in Turkmenistan, only 7% of all energy infrastructure investments were directed toward low-carbon projects, the lowest energy sustainability ratio in the region. Kazakhstan attracted a large share of carbon-intensive energy infrastructure investments (79%), which signals a lack of clear redirection from conventional to sustainable energy sources during the studied period. However, Uzbekistan demonstrated a significant shift toward sustainability where investments in low-carbon energy infrastructure projects constituted 61%. Among the other countries, Turkmenistan notably prioritized carbon-intensive projects, with 93% of its investments channeled into such infrastructure, largely focused on gas-related projects. This picture illustrates diverse energy investment priorities and trajectories within the region, with some countries increasingly investing in sustainable, low-carbon energy infrastructure, while in others a change of investment patterns towards cleaner energy sources remains to be seen despite climate commitments.

Figure 3. Distribution of investments in carbon-intensive and low-carbon energy infrastructure projects from 2008 to 2023, by country



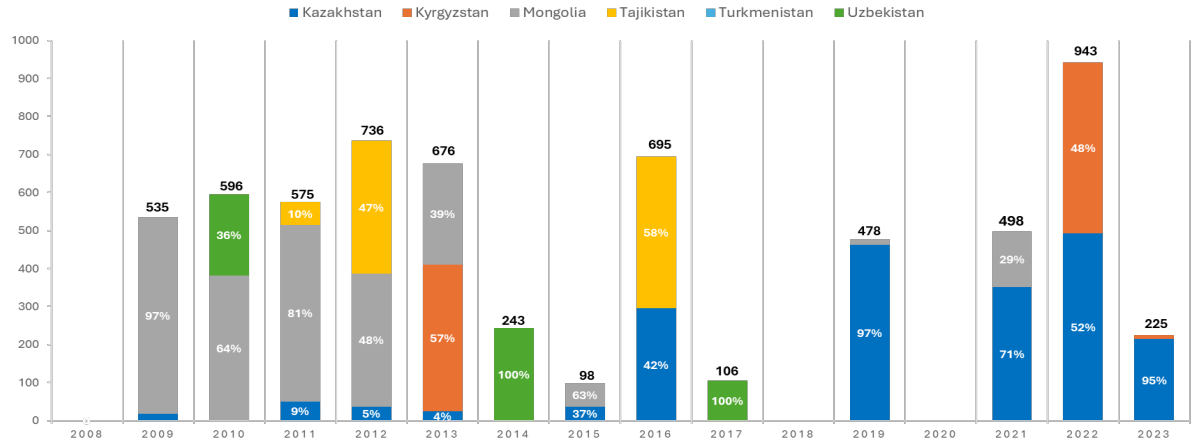
Source: based on UCA carbon-intensive and low-carbon energy infrastructure datasets (2025)

4.1. Trends in carbon-intensive energy infrastructure projects

Figure 4 illustrates the annual realized coal infrastructure investments across Central Asia from 2008 to 2023. Mongolia initially dominated, particularly between 2009 and 2011, capturing most investments, including 515 million USD (97%) in 2009 and 465 million USD

(81%) in 2011, before its investment share significantly decreased. From 2016 onward, Kazakhstan emerged as the top recipient, peaking at 463 million USD (97%) in 2019 and 493 million USD (52%) in 2022. Kyrgyzstan saw a notable surge in 2022, receiving 450 million USD (48%), while Uzbekistan and Tajikistan experienced sporadic investment peaks, such as Uzbekistan's 214 million USD (36%) in 2010 and Tajikistan's 400 million USD (58%) in 2016.

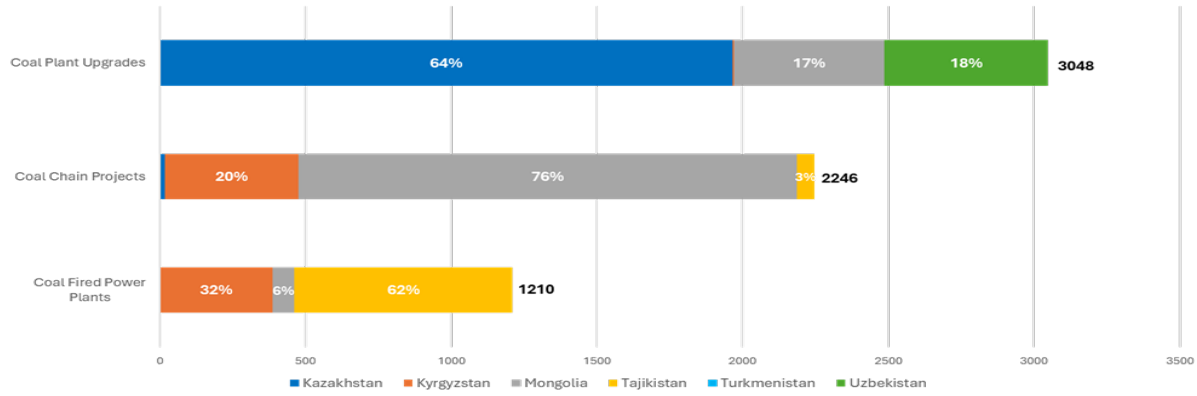
Figure 4. 2008-2023 investments in coal infrastructure projects by country, mln. USD



Source: based on UCA carbon-intensive energy infrastructure dataset (2025)

Figure 5 illustrates notable differences in investment scales across coal infrastructure projects in CA. Mongolia represents the largest share of coal-related investments, particularly in Coal Chain Projects, which refer to investments in coal mining, transportation, and processing infrastructure. These projects amount to 1.71 billion USD (76% of total investment), alongside 515 million USD (17%) allocated to Coal Plant Upgrades. In contrast, Uzbekistan's coal investments are smaller, with 563 million USD (18%) allocated to Coal Plant Upgrades and no recorded funding for Coal Chain Projects. Tajikistan has directed significant investment into Coal-Fired Power Plants, totaling 749 million USD (62%) for these projects. Kyrgyzstan, with a smaller population than Mongolia and Uzbekistan, has received moderate coal investments relative to its size. The country has attracted 386 million USD for Coal-Fired Power Plants and 456 million USD (20%) for Coal Chain Projects.

Figure 5. Total investment in coal infrastructure projects for 16 years by countries and types, mln. USD

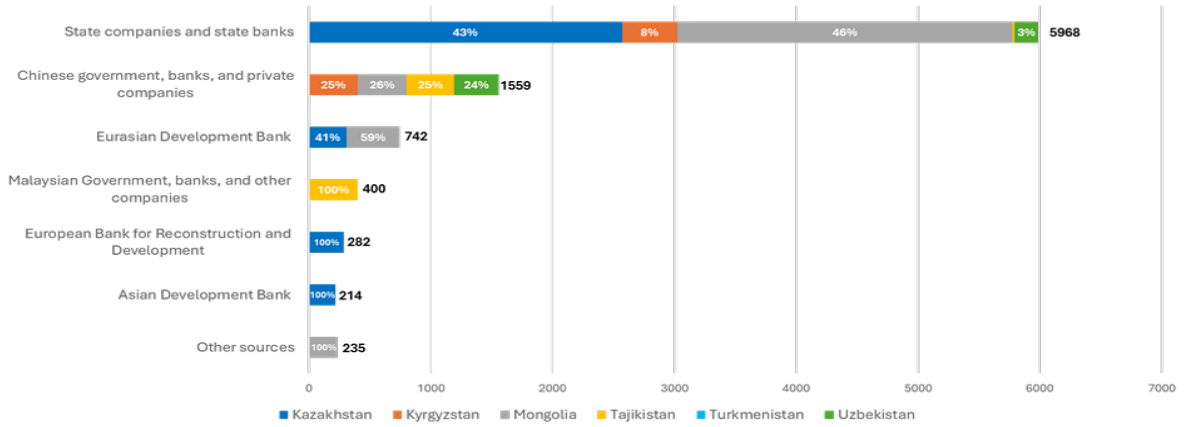


Source: based on UCA carbon-intensive energy infrastructure dataset (2025)
Note: The Coal Chain Projects include Coal Mining, Coal Transportation, and Coal Processing

Figure 6 highlights significant differences in funding sources for coal infrastructure projects across CA. Public investments, including SOEs and state-owned banks, constitute the largest share of financing in Kazakhstan (43%) and Mongolia (46%), reflecting strong government involvement in energy infrastructure. China has played a key role as an external financier of coal infrastructure projects in the region, although its level of investment has fluctuated over the years.

ADB has had a more limited role, with 214 million USD invested in Kazakhstan, primarily in modernization and efficiency upgrades of existing coal plants. Additionally, the Malaysian government, alongside banks and private entities, contributed 400 million USD to Tajikistan, suggesting a more targeted approach focused on specific projects. Other miscellaneous funding sources, totaling 235 million USD in Mongolia, have had a relatively minor impact compared to larger public or regional financiers.

Figure 6. 2008-2023 investments in coal infrastructure projects by donors and countries, mln. USD



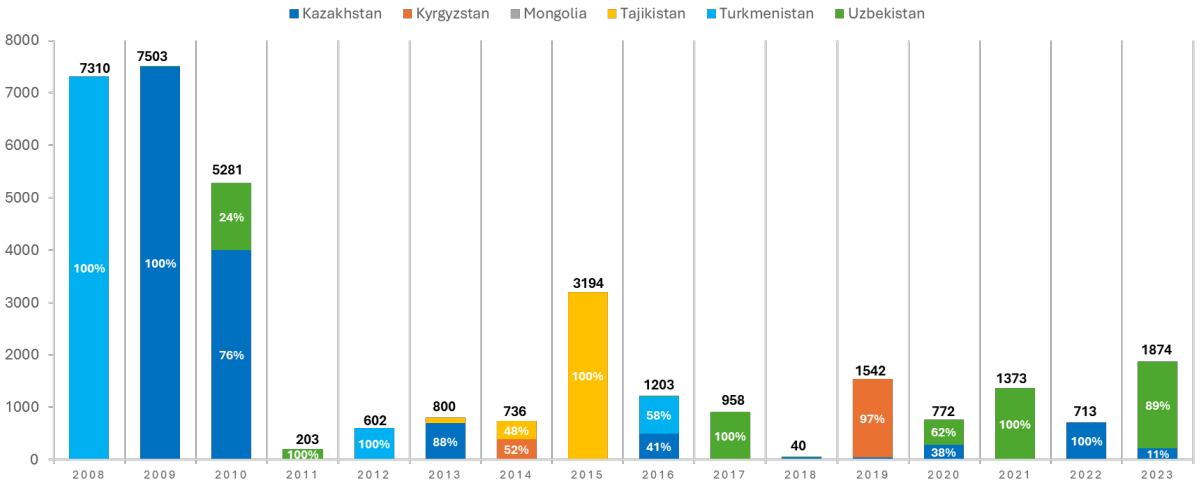
Source: based on UCA carbon-intensive energy infrastructure dataset (2025)
Note: Other sources include funding from such agencies as UNDP, Green Climate Fund, Japanese agencies, and funds, etc.

Figure 7 highlights gas infrastructure investments across CA over 16 years, with Turkmenistan and Kazakhstan receiving significant investments between 2008 and 2010, driving overall regional trends. In 2008, Turkmenistan saw the largest single-year investment of 7.31 billion USD, primarily for the CA–China Gas Pipeline (Lines A and B), which exclusively transports Turkmen gas to China, alongside 0.5 million USD for Phase 2 of the Turkmenistan-Afghanistan-Pakistan-India (TAPI) Natural Gas Pipeline, aimed at diversifying export markets. Kazakhstan's 4 billion USD investment in 2010 was largely allocated to the first stage of the second branch of the Kazakhstan–China Gas Pipeline (Beineu–Bozoi–Kyzylorda–Shymkent pipeline), receiving 1 billion USD from SOEs and banks and 3 billion USD from external sources.

The investment of 7.31 billion USD investment in Turkmenistan in 2008 was mostly driven by large-scale infrastructure projects, including the China-Central Asia Gas Pipeline, reflecting the country's commitment to expanding its export capacity and diversifying its gas markets. In contrast, Kyrgyzstan saw low levels, with a peak investment of 1.54 billion USD in 2019. Tajikistan experienced a significant investment surge in 2015, reaching 3.19 billion USD, underscoring a notable focus on gas projects during that period. Uzbekistan recorded 1.37

billion USD in investments in 2021, representing 100% of that year's regional gas infrastructure investments.

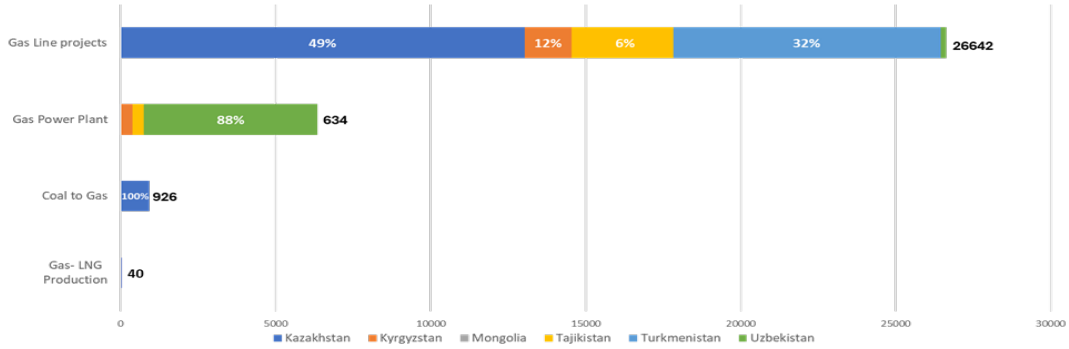
Figure 7. 2008-2023 investments in gas infrastructure projects by countries, mln. USD



Source: based on UCA carbon-intensive energy infrastructure dataset (2025)

Figure 8 illustrates significant investment in gas infrastructure projects across CA, with gas pipelines receiving the largest portion, totaling 26.64 billion USD. Kazakhstan leads in pipeline investments, holding 49% of this total (13.04 billion USD), followed closely by Uzbekistan, which accounts for 32% (8.62 billion USD). In the gas power plant sector, Uzbekistan dominates, contributing 88% of the total investment, amounting to 634 million USD. Kazakhstan is also the principal investor in coal-to-gas conversion projects, committing 926 million USD, highlighting its efforts to transition towards less emission-intensive sources than coal.

Figure 8. 2008-2023 investments in gas infrastructure projects by countries and clusters, mln. USD

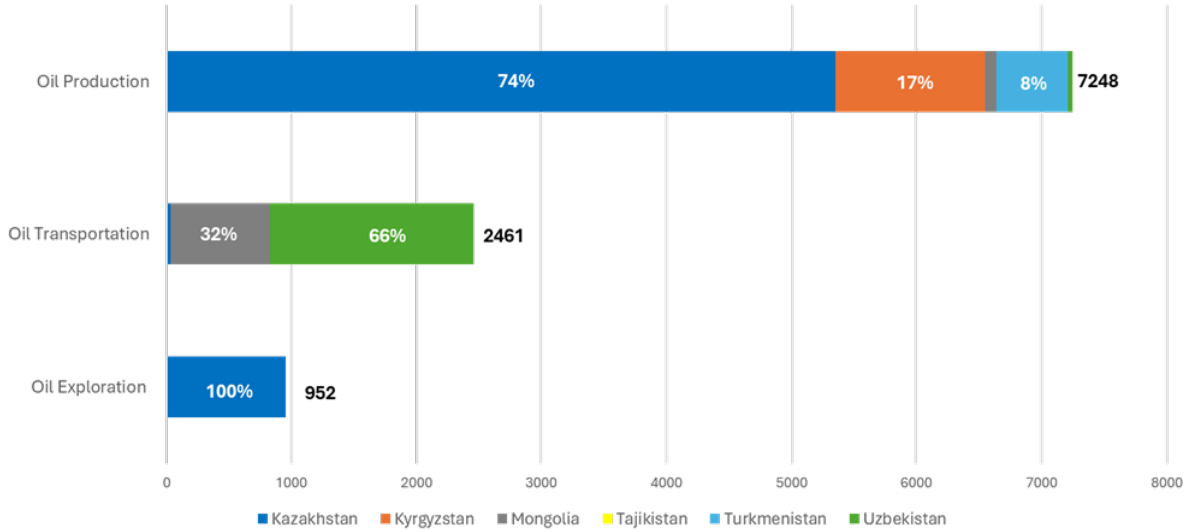


Source: based on UCA carbon-intensive energy infrastructure dataset (2025)
Note: Gas – LNG Production was 100% for Kazakhstan

Figure 9 highlights Kazakhstan's prevalence in oil investments at all stages of the industry cycle relative to neighboring countries. Kazakhstan's 100% share in oil exploration investments illustrates its leading role in discovering new resources in the region, a role supported by a strong resource base, advanced technologies, and favorable government policies that attract investment. Uzbekistan's status as the main location for oil transportation

investments (2/3 of total investment) highlights its role as a transit country, pivotal for facilitating cross-regional resource flows. Kazakhstan also leads in oil production investments, representing a significant 74%, while investments in Kyrgyzstan and Uzbekistan stand respectively at 17% and 8% of the total, respectively.

Figure 9. 2008-2023 investments in oil infrastructure projects by cluster and countries, mln. USD

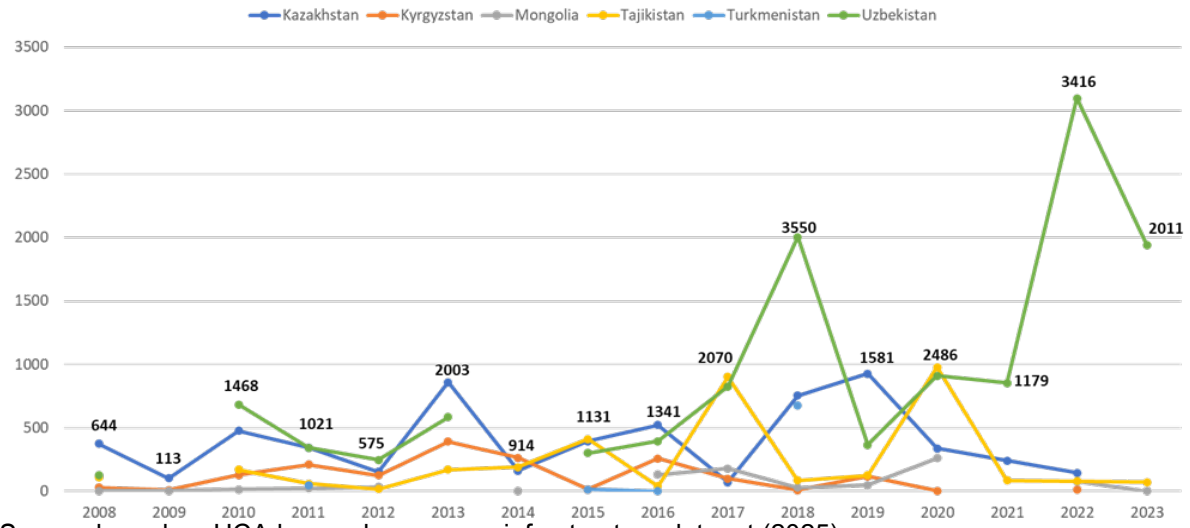


Source: based on UCA carbon-intensive energy infrastructure dataset (2025)

4.2. Trends in low-carbon energy infrastructure projects

Figure 10 shows a notable rise in investment across CA countries from 0.6 to 3.4 billion USD between 2008 and 2022. While investment dropped to 2 billion USD in 2023, it remained well above pre-2021 levels. The data highlights substantial volatility in investment flows, particularly due to large-scale infrastructure projects which often result in sharp fluctuations. Nevertheless, the overall upward trend is evident, among the six CA nations, Uzbekistan stands out as a regional leader in attracting capital for low-carbon energy infrastructure. Kazakhstan experienced fluctuations over the 16 years, with significant investment peaks in 2013 (858 million USD) and 2019 (928 million USD). Investment levels in Kyrgyzstan and Tajikistan remained relatively low and stable, showing slight peaks in 2013 (389 million USD) in Kyrgyzstan and in 2017 (902 million USD) and 2020 (977 million USD) in Tajikistan. Turkmenistan and Mongolia experienced limited to no investments in low-carbon energy infrastructure during the 16-year study period.

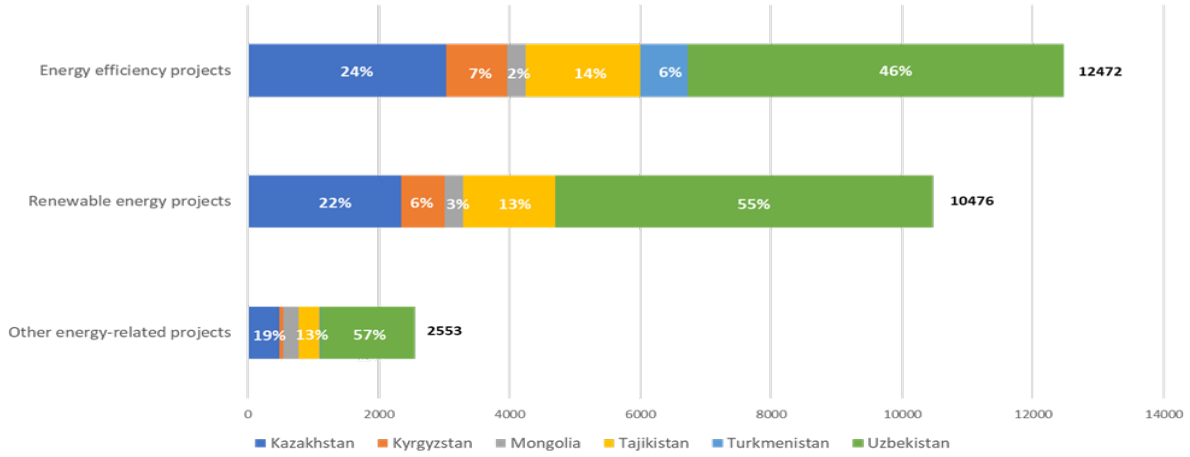
Figure 10. Dynamics of investment in low-carbon infrastructure projects for 16 years by countries, mln. USD



Source: based on UCA low-carbon energy infrastructure dataset (2025)
Note: Numbers in **bold** represent total investment in 6 CA countries for a specific year.

Figure 11 shows that among low-carbon infrastructure projects, energy efficiency projects attracted the highest level of investment in CA, reaching 12.5 billion USD over the analyzed period, mainly followed by RE projects, which totaled 10.5 billion USD. Investments in other low-carbon energy-related projects (modernization of energy equipment, grid optimization, etc.) remain comparatively low. According to the data, Uzbekistan appears as the regional leading investment destination across all three categories of energy projects, representing 46% of investments in energy efficiency, 55% in RE, and 57% in other energy-related initiatives. Kazakhstan ranks as the second largest investment location, accounting for 24% of energy efficiency investments, 22% in renewables, and 19% in other energy projects. Investments in Tajikistan contribute moderately to the total, with 13-14% across all three categories, while Kyrgyzstan follows with 6-7% in energy efficiency and RE investments. Turkmenistan and Mongolia have had limited investments across all project categories.

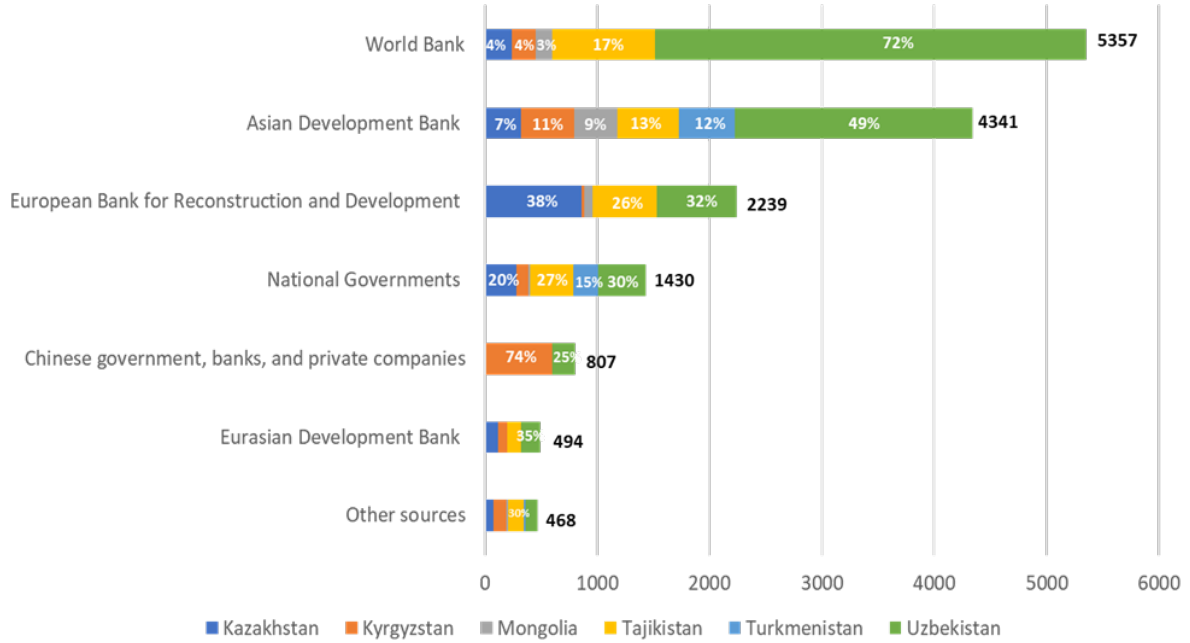
Figure 11. Total investment in low-carbon energy infrastructure projects for 16 years by countries and clusters, mln. USD



Source: based on UCA low-carbon energy infrastructure dataset (2025)
Note: Other energy-related projects include such projects as modernization of energy equipment, grid optimization, etc.

Figure 12 illustrates that, contrary to carbon-intensive energy infrastructure project investments, funding from public investments for low-carbon energy infrastructure in CA is relatively modest. This limited domestic public funding highlights the region's significant reliance on external financial support from international organizations to advance sustainable energy projects. Uzbekistan stands out as the leading recipient of World Bank investments (3.8 billion USD, i.e., 72% of the Bank's total sustainable energy investments in the region). The ADB similarly directs its largest share of investments to Uzbekistan (2.1 billion USD i.e., 49% of the total). The European Bank for Reconstruction and Development (EBRD) has contributed 2.239 billion USD over the past 16 years and Kazakhstan receiving the largest share (38%), followed closely by Uzbekistan (32%) and Tajikistan (26%). Funding from the Chinese government, including banks and private firms, comprises 807 million USD of total regional investments, with 74% of these funds directed to Kyrgyzstan.

Figure 12. Total investment in low-carbon energy infrastructure projects for 16 years by donors and countries, mln. USD

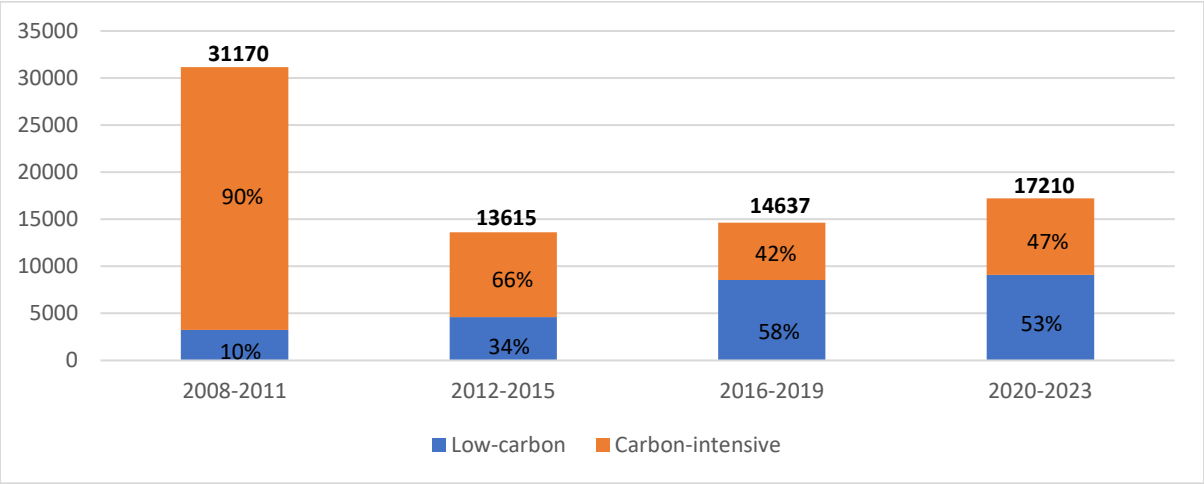


Source: based on UCA low-carbon energy infrastructure dataset (2025)
Note: Other sources include funding from such agencies as UNDP, Green Climate Fund, Japan agencies and funds, etc.

4.3. Putting all together

Figure 13 shows the distribution of investment between carbon-intensive and low-carbon energy infrastructure projects across six CA countries over a span of 16 years, divided into four consecutive periods (2008-2011, 2012-2015, 2016-2019, and 2020-2023). Over the entire period from 2008 to 2023, total investments in carbon-intensive projects amounted to 51.131 billion USD (67% of the total), while low-carbon projects received 25.501 billion USD (33% of the total).

Figure 13. Distribution of carbon-intensive and low-carbon energy infrastructure investment projects, by 4-year periods, mln. USD



Source: based on UCA carbon-intensive and low-carbon energy infrastructure datasets (2025)

As the graph demonstrates, investments in low-carbon energy infrastructure have shown a gradual increase, starting from just 10% of total investments between 2008 and 2011, being 34% and 58% of total investments between 2012-2015 and 2016-2020, respectively, and finally rising to 53% of total investments between 2020 and 2023. This shift highlights the growing commitment to sustainable energy projects in the region as nations begin to prioritize low-carbon infrastructure in their energy strategies.

5. Challenges, opportunities and ways for energy decarbonization in Central Asia

This section outlines key barriers and possibilities for energy decarbonization based on a critical reflection of policy documents, reports of international organizations, agencies, and data analysis. The energy decarbonization process in CA faces several key challenges due to the region's economic structure, reliance on fossil fuels, and infrastructural limitations. However, opportunities for energy decarbonization in CA are abundant, particularly through harnessing the region's vast RE potential, primarily solar, wind, and hydropower, while modernizing energy infrastructure and regional cooperation for cross-border energy trading can further accelerate the shift toward low-carbon economies.

5.1. Kazakhstan

For Kazakhstan, one of the primary challenges in decarbonizing its energy sector is the heavy reliance on coal and oil, especially in regions where fossil fuel extraction supports local economies. As mentioned before, Kazakhstan is considered one of the largest recipients of investments in coal infrastructure (Figure 6, 43%), gas line infrastructure (Figure 8, 49%) and oil production (Figure 9, 74%). Transitioning these communities to green energy sources requires a careful balancing act to avoid economic and social destabilization, particularly in mining areas where there is resistance due to fears of job losses and income instability (UNECE, 2023).

Another challenge is Kazakhstan's outdated energy infrastructure such as power generation facilities and transmission systems, which is primarily designed for fossil fuel production. Adapting these systems to accommodate RE sources, such as wind and solar, demands

significant investment and technological upgrades (KazEnergy, 2023). As of 2023, Kazakhstan attracted 22% of total investments in renewable energy infrastructure development which is 2.5 times lower than in Uzbekistan (Figure 11). Additionally, Kazakhstan's high energy intensity and aging energy infrastructure contribute to high CO_2 emissions and make it challenging to achieve emission reduction targets, given the need for both modernized technology and large-scale capital input (Satubaldina & Andresh, 2023).

Kazakhstan has significant opportunities for energy decarbonization, particularly through its abundant RE resources. The country is strategically positioned to harness wind and solar energy, with the potential to generate 2.5 million GWh annually from renewable sources (KazEnergy, 2023). Another opportunity lies in regional cooperation. Kazakhstan can collaborate with neighboring countries to develop a unified energy grid, enabling the sharing of RE resources and stabilizing energy supply across CA (Asian Development Bank, 2023).

This collaboration could also enhance energy security and reduce dependence on fossil fuels, thus supporting both economic growth and environmental sustainability. The government can establish clear incentives, such as tax breaks and feed-in tariffs, to attract both domestic and foreign investments in solar, wind, and hydroelectric projects. This diversification is crucial, as the country's reliance on fossil fuels poses significant environmental challenges and hampers efforts to reduce GHG emissions (World Bank, 2021).

5.2. Kyrgyzstan

Kyrgyzstan faces several challenges in its efforts to achieve energy decarbonization, with a major issue being the low share of grants allocated to low-carbon energy projects (Suyunbaev, 2021). Among the projects received over the past 16 years, a larger proportion in Kyrgyzstan has been focused on carbon-intensive energy (70%) compared to low-carbon energy projects (30%) (Figure 3). Another challenge for Kyrgyzstan is an outdated infrastructure and inadequate investment in modernizing energy systems, hinders the development of more efficient technologies and integration of RE sources (UNDP, 2019). Political instability and governance issues can also impede effective policy implementation, creating uncertainty for investors and slowing the transition to a low-carbon economy (Suyunbaev, 2021).

Despite these challenges, Kyrgyzstan presents significant opportunities for energy decarbonization. The country boasts substantial RE potential, particularly in hydropower, solar, and wind energy, which can be harnessed to diversify its energy mix (IRENA, 2021). Recent reforms and commitments to international agreements, such as the Paris Agreement, signal a political will to transition towards a greener economy (UNDP, 2019). In line with this direction, the government has also updated its national programs by strengthening energy decarbonization goals and revised its NDC to enhance its commitment to achieving a low-carbon development pathway. Additionally, investments in energy efficiency measures, supported by international financial institutions and NGOs, could enhance energy security and reduce emissions while fostering economic growth (World Bank, 2020). Engaging local communities and promoting PPPs can also stimulate innovation and mobilize resources for sustainable energy projects, contributing positively to Kyrgyzstan's role in the region's decarbonization efforts.

To diversify its energy portfolio, Kyrgyzstan may consider pursuing the integration of solar and wind energy sources. Developing policies that support the installation of decentralized RE

systems, particularly in rural areas, can enhance energy access and sustainability. The government can also foster stakeholder engagement by promoting public participation in RE projects and raising awareness about the benefits of energy conservation. By encouraging community-driven initiatives, Kyrgyzstan can cultivate a culture of sustainability and innovation that aligns with its national energy objectives (IRENA, 2021).

5.3. Mongolia

Mongolia faces critical challenges in reducing its CO_2 emissions due to its deep reliance on coal, which powers most of its energy infrastructure. As shown in Figure 3, 79% of Mongolia's total energy investments, amounting to 3.88 billion USD, are still allocated to carbon-intensive projects, leaving only 21% for low-carbon alternatives. This reflects the country's structural dependence on fossil fuels, reinforced by Figure 4, which shows a significant share of coal-related projects in Mongolia from 2008 to 2023, peaking in 2012 and 2013. Figure 5 further confirms this trend, highlighting that Mongolia dominates coal chain project investments, making up 76% (2.25 billion USD) of the total coal chain expenditure.

Despite efforts to diversify, the transition to renewable sources such as wind and solar is impeded by high infrastructure costs, limited financing options, and a lack of advanced technology (Law of Mongolia on energy, 2015). The country's energy infrastructure is largely built around fossil fuels, meaning a shift to renewables would require expensive upgrades and new investments. The lack of a smart and interconnected transmission grid hampers the efficient distribution of RE, making it difficult to fully capitalize on Mongolia's vast RE potential. The transition to RE also faces technical and climatic challenges. For instance, solar panels experience a significant drop in efficiency during Mongolia's harsh winters, often operating at only 30% of their optimal capacity. This makes it difficult to rely solely on solar energy, especially during peak winter demand periods when energy consumption is highest (UNDP 2024).

On the other hand, Mongolia holds significant opportunities to advance its RE sector. The Gobi Desert has vast potential for solar and wind energy, with annual solar capacity up to 1,600 kWh/m² and wind speeds suitable for large-scale production, making it ideal for domestic energy supply and potential energy exports (ICMS, 2013). Expanding hydropower, with projects like the Rogun Hydroelectric Power Plant, would further diversify the energy mix and reduce coal dependency, aligning with Mongolia's carbon reduction goals. Additionally, Mongolia's commitment to the Paris Agreement and support from international institutions like the ADB and partnerships through CAREC facilitate financial and technological backing for renewable initiatives. These efforts, along with structured tariffs and the Renewable Energy Fund, are driving private investment and accelerating Mongolia's shift toward a sustainable, low-carbon energy system, bolstering its economy and environmental ambitions (NDC, 2020).

5.4. Tajikistan

Tajikistan's path toward carbon neutrality is constrained by deep structural and financial hurdles, despite its renewable energy ambitions. As shown in Figure 3, carbon-intensive investments still represent 64% (1.04 billion USD) of the country's total energy financing, while only 36% (590 million USD) is directed toward low-carbon alternatives. This imbalance reflects a reactive reliance on coal and imported fossil fuels to compensate for seasonal fluctuations in hydropower availability, particularly during winter months when river flows decline. Figure 4

reinforces this challenge by showing that coal investments in Tajikistan surged between 2011 and 2016, reflecting the government's effort to stabilize energy supply during critical periods.

However, these investments contradict long-term decarbonization goals and demonstrate the difficulty of maintaining hydropower as a reliable base load without complementary energy sources. As indicated in the Figure 5, while Tajikistan's coal investments are less dominant than Mongolia's, they still include over 400 million USD in coal-fired power generation, signaling continued reliance on fossil fuels. Furthermore, outdated energy infrastructure, resulting in significant transmission losses and limited rural access, are factors that impede equitable energy distribution and hinder RE integration. The estimated 11.5 billion USD required to meet Tajikistan's NDC targets underscores the critical role of international financing and institutional reform in accelerating a sustainable energy transition (NDC, 2021).

Tajikistan's path to carbon neutrality is challenged by its reliance on seasonal hydropower, outdated infrastructure, and financial constraints. The country depends heavily on hydropower, which fluctuates with seasonal river flows and often leads to energy shortages during winter. To compensate, Tajikistan resorts to coal and imported energy, straining its carbon reduction goals (PSD master plan, 2017). Additionally, the estimated 11.5 billion USD needed to meet NDC targets underscores the nation's financial constraints, with a heavy reliance on international funding to cover these needs (NDC 2021). Despite these obstacles, Tajikistan possesses significant opportunities in RE expansion and regional energy trade. The country's vast hydropower potential, with only 4% currently utilized, presents a chance to boost energy supply with projects like the Rogun Hydroelectric Power Plant, which aims to add 3,600 MW of clean energy capacity (PSD master plan, 2017). This development could stabilize Tajikistan's energy supply year-round and potentially generate surplus energy for export, fostering economic growth and revenue generation (NDC, 2021).

5.5. Turkmenistan

In Turkmenistan, the challenges for decarbonization are largely tied to its significant reliance on natural gas production, which accounts for a large portion of both government revenue and exports. As mentioned earlier in Figure 8, Turkmenistan had received 32% of total investments in gas line projects in CA over 16 years. Transitioning from a gas-based economy requires a shift in policy priorities, including economic diversification to reduce dependence on gas exports. However, the country's state-controlled energy policies have traditionally been slow to change, creating a barrier to rapid decarbonization efforts (Eurasianet, 2023).

Another challenge is the limited availability of RE resources and infrastructure within Turkmenistan, which lacks significant wind or solar installations despite its arid climate. This can be seen in Figure 11, where Turkmenistan's investment trends in the development of renewable energy sources are just around 1%, while energy efficiency-related investments constitute only 6%. Developing RE infrastructure requires both capital and expertise, which remain limited under current policies (Kabbaj & Baum, 2023). Finally, the lack of policy frameworks specifically geared toward decarbonization creates regulatory uncertainty, discouraging potential investors in RE projects (IEA, 2023).

In Turkmenistan, the transition to a decarbonized energy sector presents substantial opportunities, primarily through diversifying its economy away from natural gas dependency. The country possesses substantial potential for solar energy, given its high levels of sunshine

throughout the year (Kabbaj & Baum, 2023). Developing solar energy projects could not only fulfill domestic energy needs but also position Turkmenistan as an energy exporter in the renewable sector, tapping into international markets. Additionally, Turkmenistan's strategic geographic location offers a unique opportunity for investment in RE infrastructure that connects Central Asia with neighboring regions, particularly through the construction of transnational energy lines (IEA, 2023).

5.6. Uzbekistan

Uzbekistan encounters various challenges in its pursuit of energy decarbonization. A significant barrier is the country's heavy dependence on natural gas, which accounts for about 80% of its energy supply (World Bank, 2021). This reliance on fossil fuels complicates efforts to transition to a low-carbon economy, especially as investments in RE remain limited (ADB, 2020). Furthermore, like other CA countries, the existing energy infrastructure is often outdated and inefficient, resulting in high levels of energy loss during transmission and distribution (IEA, 2022). These factors can deter foreign investment and hinder the development of a diversified energy portfolio.

Despite these challenges, Uzbekistan holds significant opportunities for advancing energy decarbonization. The country has abundant RE resources, particularly in solar and wind, with the potential to generate up to 100 GW of solar power alone (IRENA, 2021). The government has demonstrated a commitment to RE development through ambitious targets outlined in its energy strategy, aiming for 30% of its energy mix to come from renewable sources by 2030 (ADB, 2020). Among other CA countries, Uzbekistan is the only one that has received a higher proportion of funding for low-carbon energy projects (61%) compared to carbon-intensive projects (39%) (Figure 3). International partnerships and investments can facilitate the transition by providing technology transfer and financial resources necessary for scaling up renewable projects (World Bank, 2021).

In addition, implementing training programs focused on building local expertise in renewable technologies will support long-term sustainability and economic growth. These initiatives can create job opportunities and empower communities to participate actively in the transition. Collaborating with international organizations and leveraging financial support for technology transfer will enhance Uzbekistan's capacity to meet its decarbonization goals effectively. By fostering an inclusive approach that engages local stakeholders, Uzbekistan can create a robust framework for sustainable energy development that benefits its economy and environment (IRENA, 2021).

6. Conclusion

This paper explores the progress of Central Asian countries in reducing CO_2 emissions in the energy sector by examining investment trends in carbon-intensive and low-carbon energy infrastructure from 2008 to 2023. The findings indicate that while carbon-intensive projects continue to play a dominant role, there is a growing potential for low-carbon initiatives. By analyzing investment patterns across six CA countries, the study identifies key energy policies and the shifting dynamics of energy infrastructure development. Additionally, it highlights major challenges and opportunities for energy decarbonization and offers policy recommendations tailored to each country's specific context, aiming to facilitate meaningful progress toward a low-carbon energy transition in the region.

CA has experienced rising CO_2 emissions due to its heavy reliance on fossil fuels, particularly coal, oil, and gas, to meet increasing energy demands. Another significant driver of the carbon intensity of CA economies is the region's outdated and energy-intensive infrastructure, which requires substantial investment for modernization. Industrialization and economic growth have further driven GHG emissions, exacerbating environmental challenges such as air, water, and soil pollution. At the same time, this energy-intensive development model underscores the urgent need for sustainable solutions, fueling interest in decarbonization strategies to mitigate environmental impacts and growing commitment to contributing to global climate action and fulfilling obligations under the Paris Agreement. Moving forward, aligning regional development with low-carbon pathways will be crucial to ensure both environmental sustainability and long-term energy security in Central Asia. Moving forward, integrating just transition plans at the sub-national level will be essential to ensure that decarbonization efforts also promote inclusive economic development and long-term energy security across Central Asia.

Acknowledgements

We would like to acknowledge the role of the OECD SIPA in collecting relevant information and discussing the results of the analysis. We would also be grateful for the following team members who made contributions (in different forms) to this background paper: Safdar Jan (MA Economics, Simon Fraser University), Didar Ali (Student at the Aga Khan University Faculty of Arts and Science and Global Encounters Intern), Kairat Berdishaliev (UCA SAS graduate), Zhamal Akmatova (UCA, SAS Faculty Coordinator), Dr. Madina Junussova (Interim Director, Civil Society Initiative, Urban Development Lead, Graduate School of Development, Senior Research Fellow, Institute of Public Policy and Administration) and Saniya Soltybayeva (PhD Candidate, Nazarbayev University).

References

Asian Development Bank. (2020). Uzbekistan: Energy sector assessment, strategy, and road map. Retrieved from https://www.adb.org/publications/uzbekistan-energy-sector-assessment-strategy-road-map

Cabinet of Ministers of the Kyrgyz Republic. (2023). *Implementation of Energy Conservation and Energy Efficiency Policy in the Kyrgyz Republic for 2023-2027.* https://cbd.minjust.gov.kg/160277/edition/1264523/ru

Energy Charter Secretariat. (2013, November). ICMS 2013. https://www.energycharter.org/fileadmin/DocumentsMedia/ICMS/ICMS-Mongolia_2013_en.pdf

Eurasianet. (2023). *Turkmenistan's Energy Sector and Decarbonization Obstacles*. Retrieved from https://eurasianet.org/turkmenistan-fiddling-while-gas-leaks

Government of Kazakhstan. (2024). *Sustainable industrial transformation strategy*.

Government of Mongolia - Ministry of Energy. (2015). *Law of mongolia on energy*. Law of Mongolia No. 6 of 2001 on Energy (2015 Ed.) | ESCAP Policy Documents Managment. https://policy.asiapacificenergy.org/node/2209

Government of the Republic of Tajikistan . (2021). *1. vision for climate change* . Updated Nationally Determined Contributions (NDC) of the Republic of Tajikistan. https://policy.asiapacificenergy.org/node/4524/portal?_gl=1%2Ai00gxp%2A_ga%2ANTI0MTY1MzcxLjE3MzAyNjcxMTQ.%2A_ga_SB1ZX36Y86%2AMTczMDI2NzExNS4xLjAuMTczMDI2NzExNi41OS4wLjA.%2A_ga_NV2GF32X0C%2AMTczMDI2NzExNS4xLjAuMTczMDI2NzExNi4wLjAuMA

https://mineconom.gov.kg/froala/uploads/file/6a0723b1ddba1f85fce34897e6654f6765710262.pdf

IEA (2023), Tracking SDG7: The Energy Progress Report, 2023, IEA, IRENA, UNSD, World Bank, WHO. 2023. Tracking SDG 7: The Energy Progress Report. World Bank, Washington DC. © World Bank., Paris https://www.iea.org/reports/tracking-sdg7-the-energy-progress-report-2023, Licence: CC BY NC 4.0

International Energy Agency (IEA). (2023). *Turkmenistan 2023 Energy Policy Review*. Retrieved from https://www.iea.org/countries/turkmenistan

International Energy Agency. (2022). Turkmenistan energy outlook 2022. https://www.iea.org/reports/turkmenistan-energy-outlook-2022

International Energy Agency. (2022). Uzbekistan energy outlook 2022. Retrieved from https://www.iea.org/reports/uzbekistan-energy-outlook-2022

International Renewable Energy Agency. (2021). Renewable energy prospects: Kyrgyzstan. https://www.irena.org/publications/2021/Oct/Renewable-Energy-Prospects-Kyrgyzstan

International Renewable Energy Agency. (2021). Renewable energy prospects: Uzbekistan. Retrieved from https://www.irena.org/publications/2021/Jun/Renewable-Energy-Prospects-Uzbekistan

International Renewable Energy Agency. (2021). Renewable energy prospects: Kyrgyzstan. https://www.irena.org/publications/2021/Oct/Renewable-Energy-Prospects-Kyrgyzstan

Kabbaj, A., & Baum, A. (2023). *Challenges in Developing Renewable Energy Infrastructure in Central Asia: Turkmenistan's Path to Decarbonization*. Retrieved from https://eurasianet.org/turkmenistan-renewable-energy-policy

Kyrgyz Republic. (2018). *National Development Strategy of Kyrgyzstan (2018-2040)*. https://mineconom.gov.kg/storage/directs/documents/209/15421950795bec078718fff.pdf

Kyrgyz Republic. (2019). *Program for the Development of the Green Economy in the Kyrgyz Republic for 2019-2023.*

Kyrgyz Republic. (2021). *Updated Nationally Determined Contribution.* https://policy.asiapacificenergy.org/sites/default/files/Updated%20Nationally%20Determined%20Contribution%202021%20%28EN%29.pdf

Legislative Chamber of the Republic of Uzbekistan. (2019). *Law of the Republic of Uzbekistan On the Utilization of Renewable Energy Sources dated 21.05.2019.* Retrieved from https://lex.uz/docs/4346835

Ministry of Energy of the Republic of Kazakhstan. (2020). *Renewable energy development program.* Republic of Kazakhstan.

Ministry of Environmental Protection of the Republic of Kazakhstan. (2013). *The concept of transition of the Republic of Kazakhstan to a green economy.* Republic of Kazakhstan. Retrieved from https://faolex.fao.org/docs/pdf/kaz179494.pdf

Ministry of Environmental Protection of the Republic of Kazakhstan. (2013). *National emissions trading system framework.* Republic of Kazakhstan.

Mongolia's nationally determined contribution. (n.d.-a). https://unfccc.int/sites/default/files/NDC/2022-06/First Submission of Mongolia's NDC.pdf

OECD (2019), Sustainable Infrastructure for Low-Carbon Development in Central Asia and the Caucasus: Hotspot Analysis and Needs Assessment, Green Finance and Investment, OECD Publishing, Paris, https://doi.org/10.1787/d1aa6ae9-en.

Power sector development master plan ... (n.d.). https://mewr.tj/wp-content/uploads/files/Power_Sector_Master_Plan-Vol2.pdf

Republic of Kazakhstan. (2022). *Nationally determined contribution*. Retrieved from https://unfccc.int/sites/default/files/NDC/2023-06/12updated%20NDC%20KAZ_Gov%20Decree313_19042023_en_cover%20page.pdfb

Republic of Uzbekistan. (2021). Updated Nationally Determined Contribution https://unfccc.int/sites/default/files/NDC/2022-06/Uzbekistan_Updated%20NDC_2021_EN.pdf

Republic of Uzbekistan. (2022). *Presidential Decree on Measures to Increase the Efficiency of Reforms Aimed at Transitioning the Republic of Uzbekistan to a Green Economy by 2030.* Retrieved from https://www.lex.uz/ru/docs/6303233

Satubaldina, A., & Andresh, M. (2023). *Kazakhstan's Challenges and Progress Toward Carbon Neutrality*. Retrieved from https://astanatimes.com/2024/10/green-hydrogen-in-kazakhstan-what-are-opportunities-and-challenges/

State Great Khural (Parliament) of Mongolia. (2016). *Mongolia Sustainable Development Vision 2030*. Mongolia Sustainable Development Vision 2030 | ESCAP Policy Documents Management. https://policy.asiapacificenergy.org/node/3762

Suyunbaev, K. (2021). Governance challenges for renewable energy development in Kyrgyzstan. *Energy Policy*, 151, 112247. https://doi.org/10.1016/j.enpol.2021.112247

United Nations Development Programme. (2019). Kyrgyzstan's energy sector: A strategic overview. Retrieved from https://www.kg.undp.org/content/kyrgyzstan/en/home/library/environment_climate_change/energy-sector-overview.html

United Nations Development Programme. (2019). Kyrgyzstan's energy sector: A strategic overview. https://www.kg.undp.org/content/kyrgyzstan/en/home/library/environment_climate_change/energy-sector-overview.html

United Nations Development Programme. (2020). Sustainable energy in Uzbekistan: Key challenges and opportunities. Retrieved from https://www.uz.undp.org/content/uzbekistan/en/home/library/environment_climate_change/sustainable-energy-in-uzbekistan.html

United Nations Economic Commission for Europe (UNECE). (2023). *Supporting Kazakhstan's Sustainable Development Goals*. Retrieved from https://unece.org/sites/default/files/2024-01/ENG%20Policy%20Brief%20presentation_Aug24.pdf

World Bank. (2020). Kyrgyz Republic: Country environmental analysis. Retrieved from https://openknowledge.worldbank.org/handle/10986/34014

World Bank. (2021). Uzbekistan: Country environmental analysis. Retrieved from https://openknowledge.worldbank.org/handle/10986/34990

Appendix 1. Aggregation of energy decarbonization policies

	Kazakhstan	Kyrgyzstan	Mongolia	Tajikistan	Turkmenistan	Uzbekistan
GHG targets	Unconditional target: 15% reduction in GHG emissions by 2030, relative to 1990 levels. Conditional target: 25% reduction in GHG emissions by 2030, relative to 1990 levels	Unconditional reduction: 15.97% by 2030. With international support: 43.62% by 2030.	22.7% reduction by 2030. Additionally, by incorporating forest-based carbon sinks, the total reduction could reach 44.9%	Conditional reduction: 50-60% with international support	20% in 2030 compared to the emissions in 2010	Initial target set as 10% in 2010, it was reviewed in 2024 and increased up to 35%
Commitment to net zero (year)	2060	2050	2050	2045	2030	2050
Plans for increasing the share of RE	Aims to generate 15% of its electricity from RES by 2030 and 50% by 2050 over 2008 level	Targets to produce 10% RE share by 2027	Expands renewables to 30% and begins using nuclear energy.	Diversifies the country's electric energy system capacity by at least 10%	Increases the role of RE sources by 30%	Plans to bring share of RE sources to 25% of total power generation by 2030

Source: aggregation based on open source and publicly available data