BACKGROUND STUDY REPORT

TRANSPORT TRANSITION TO DECARBONISATION IN CENTRAL ASIA

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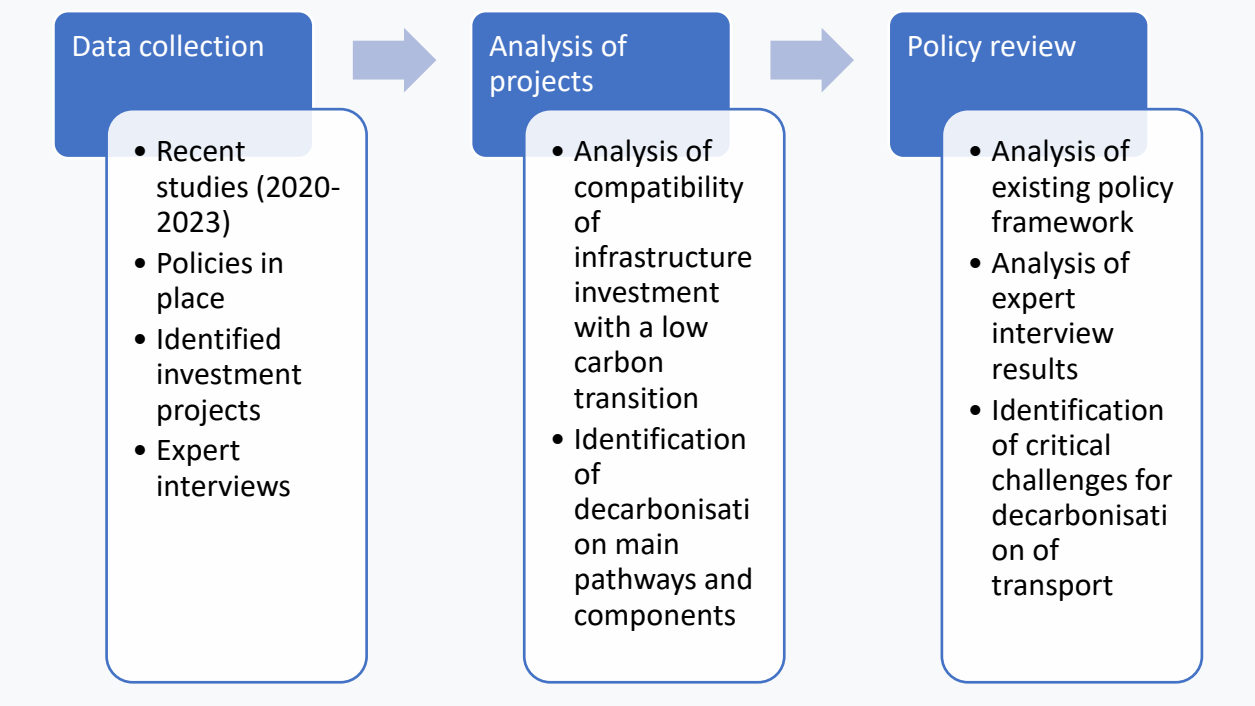
Introduction

The background study report aims to assess the policy environment in the Central Asian (CA) region to understand to what extent current policy measures are sufficient to shift the countries towards more sustainable transport projects. The study contributes to the implementation of the Sustainable Infrastructure Programme in Asia (SIPA) framework, led by the Organisation for Economic Co-operation and Development (OECD) and funded by the German Government: www.sipa-centralasia.org. The SIPA aims to help Central and Southeast Asian countries ensure that energy, transport, and industrial infrastructure investments are aligned with low-emission development pathways that are compatible with the Paris Agreement and the Sustainable Development Goals.

The CA countries of study include Kazakhstan, Uzbekistan, Kyrgyzstan, Tajikistan, Turkmenistan, and Mongolia. The study employed a comprehensive research approach, including a literature and policy review, quantitative investment data analysis, and qualitative interviews with key experts from CA countries (Figure 1.1). The authors compiled three databases using data from open sources, including government websites, websites of international financial institutions and organisations, as well as web resources with academic research, focusing on (1) transport investment projects, (2) transport decarbonisation studies, and (3) decarbonisation policies in Central Asian countries. The collected databases were analysed to determine the current situation and identify trends in project finance and policies aimed at decarbonising the transport sector in Central Asia.

Figure 1.1 The main steps of data collection and analysis



The transport projects dataset includes infrastructure projects in transport covering 15 years (2008-2022). The transport projects were selected based on their relevance to decarbonisation efforts in the transportation sector (Gota et al., 2019; ITF, 2021; World Bank Group, 2021). Projects considered were those related to:

- road quality improvement,

- railway freight capacity development,
- public transport development,
- intelligent transport systems development,
- improvement of rail track maintenance,
- enhancing port's cargo handling capacity,
- warehouse logistics development,
- enhancing energy efficiency of railway transport,
- railway construction and modernisations,
- and improving the efficiency of the railway network.

Projects were categorised based on their type, including loans, technical assistance, or grants, as well as by sources and amounts of funding. The data on projects was collected from authoritative sources, such as the official websites of national and international organisations. The policies dataset comprises all primary policy documents approved in the study countries that have an impact on the decarbonization of the transport sector, along with their objectives and an analysis of implementation challenges.

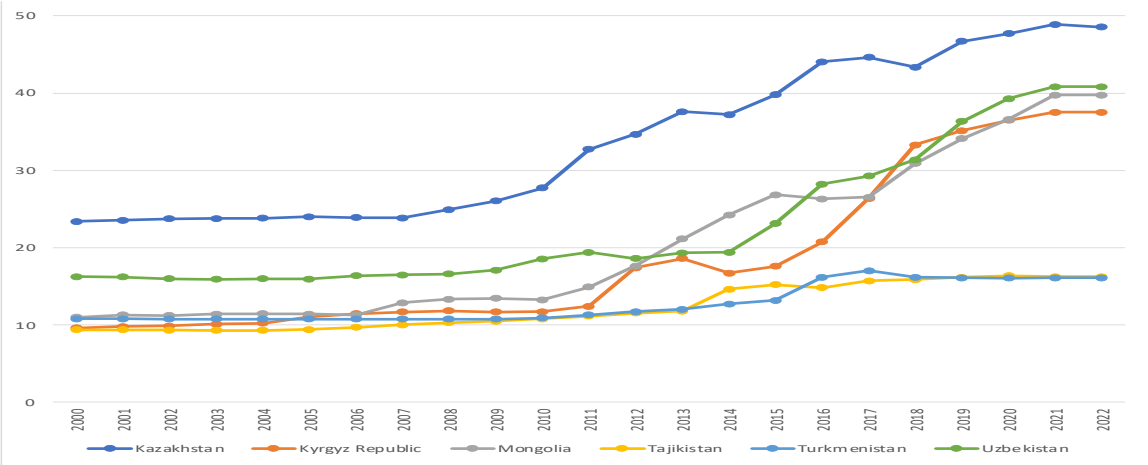
The authors developed interview questions for expert interviews based on the identified information gaps from transport decarbonisation project analysis, literature and policy reviews. The expert interviews were conducted with seven representatives from national governments (4 experts) and think tanks (3 experts) from five CA countries: Kazakhstan (2 experts), Kyrgyzstan (2 experts), Tajikistan (1 expert), Mongolia (1 expert) and Uzbekistan (1 expert). The interview questions focused on the experience in decarbonising the transport sector, trends in infrastructure investment and climate change policies in Central Asia. Policy recommendations for CA governments were formulated based on the analysis of the interview data combined with the findings of the previously conducted transport decarbonisation project analysis, literature and policy reviews.

1. Progress in achieving sustainable development and the contribution of transport to greenhouse gas emissions.

1.1 Contribution to achieving sustainable development goals

CA countries made substantial progress towards achieving the sustainable development goal (SDG) 9 on Industry, Innovation, and Infrastructure, including transport infrastructure improvements. SDG 9 aims to upgrade infrastructure and retrofit industries by 2030 by enhancing resource-use efficiency and adopting cleaner, environmentally sound technologies, and industrial processes. Therefore, achieving SDG 9 is important for reducing carbon emissions in the transport sector and aligning with global efforts to combat climate change. All CA countries report improving their performance in achieving SDG 9, see Figure 1.2. Tajikistan and Turkmenistan have nearly doubled or tripled their progress towards achieving SDG9 in 2022 compared to 2000. However, even the highest result of 50% performed by Kazakhstan is still comparatively lower than other countries with economies dependent on fossil fuels such as Finland, which achieved a 62% progress.

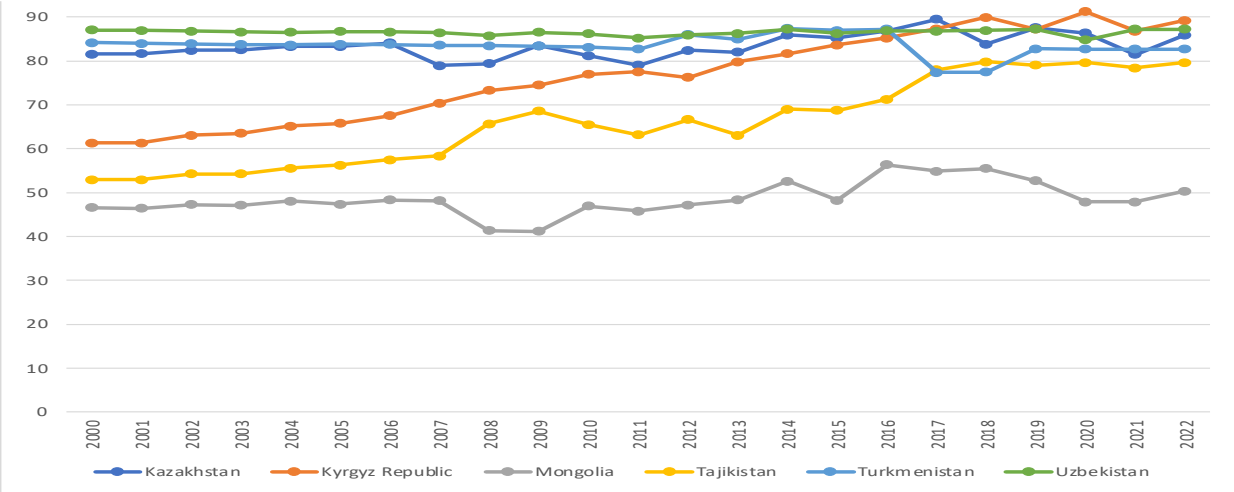
Figure 1.2 CA countries trend in progressing towards achieving SDG9, 2000-2022, in %[1]



Source: UCA (2023) Central Asian dataset on SDGs 2000-2022

CA countries report high performance in reaching SDG11: Sustainable Cities and Communities, but people are unsatisfied with the public transport system. SDG 11, calling for prioritisation of efficient urban transport, is also crucial for ensuring the decarbonisation of urban transport and making CA cities sustainable. By promoting efficient transportation systems, cities can reduce their reliance on carbon-intensive transport modes, reducing greenhouse gas emissions. The situation in Kazakhstan, Turkmenistan, and Uzbekistan in achieving SDG11 has remained chiefly unchanged (see Figure 1.3). At the same time, Kyrgyzstan stated considerable progress in achieving Goal 11, with the highest score across the CA region above 90% in 2020. All CA countries, except Mongolia, have also shown good progress in achieving SDG11, ranging from 80%-88%. However, the level of satisfaction with public transport remained heterogenous in all CA countries, see Figure 1.4. Only Uzbekistan and Tajikistan reached 75-85% in 2017-2022. The public transport performance in Kazakhstan dropped from almost 90% in 2014 to below 60% in 2017.

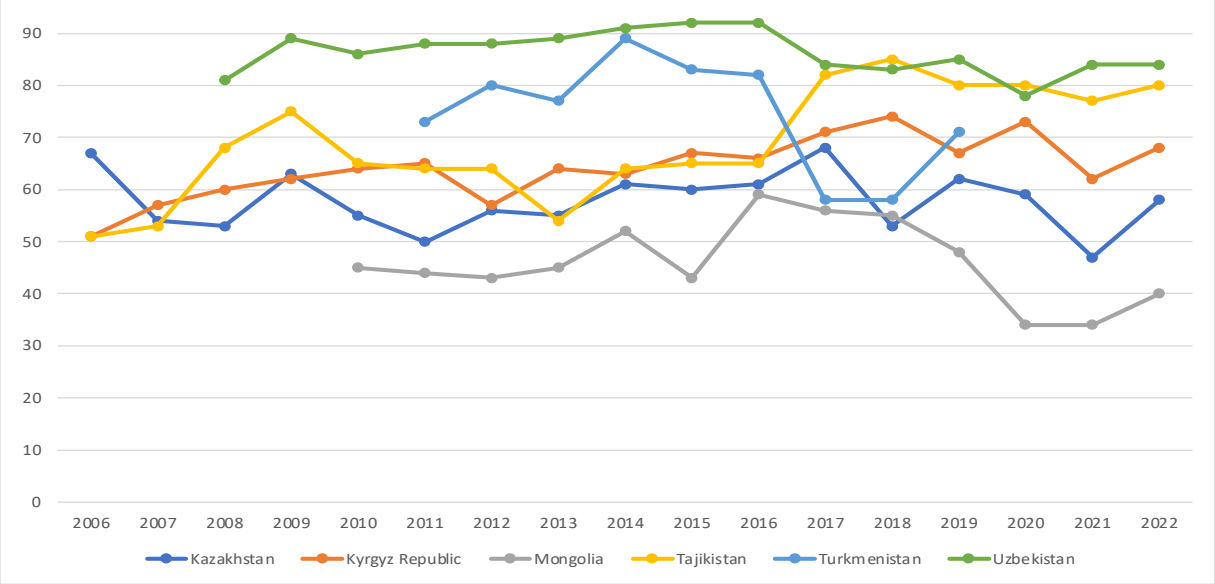
Figure 1.3 CA countries trend towards achieving SDG11: Sustainable Cities and Communities, 2000-2022, in %[2]



Source: UCA (2023) Central Asian dataset on SDGs 2000-2022

[1] The score can be interpreted as a percentage of SDG achievement. A score of 100 indicates that all SDGs have been achieved.
[2] The score can be interpreted as a percentage of SDG achievement. A score of 100 indicates that all SDGs have been achieved.

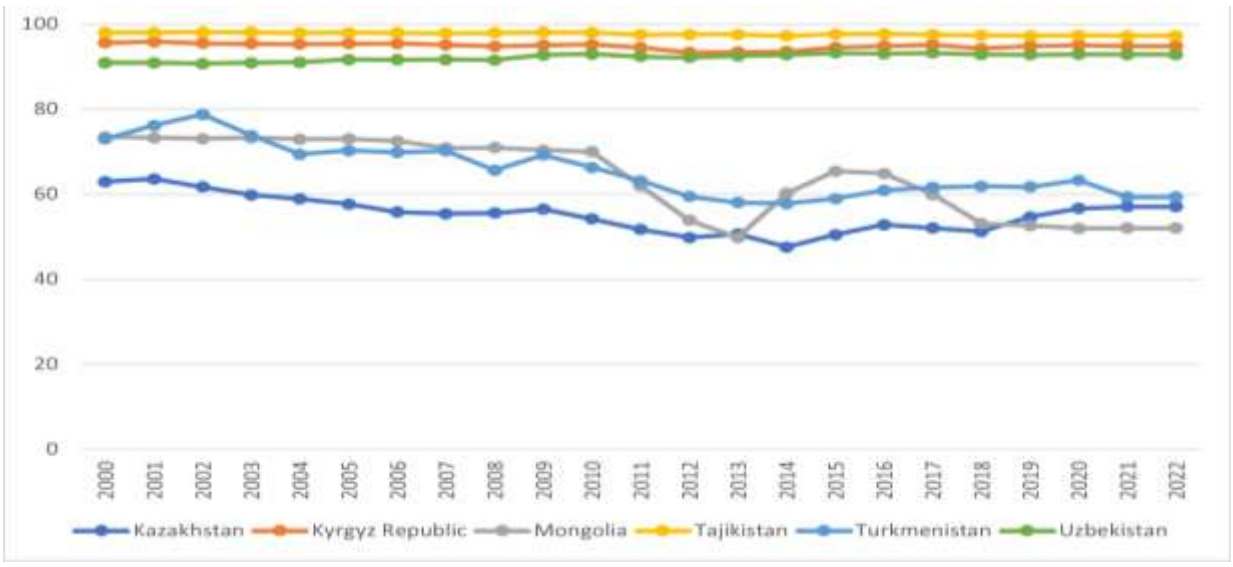
Figure 1.4 The level of satisfaction with public transport in CA, in %.



Source: UCA (2023) Central Asian dataset on SDGs 2000-2022

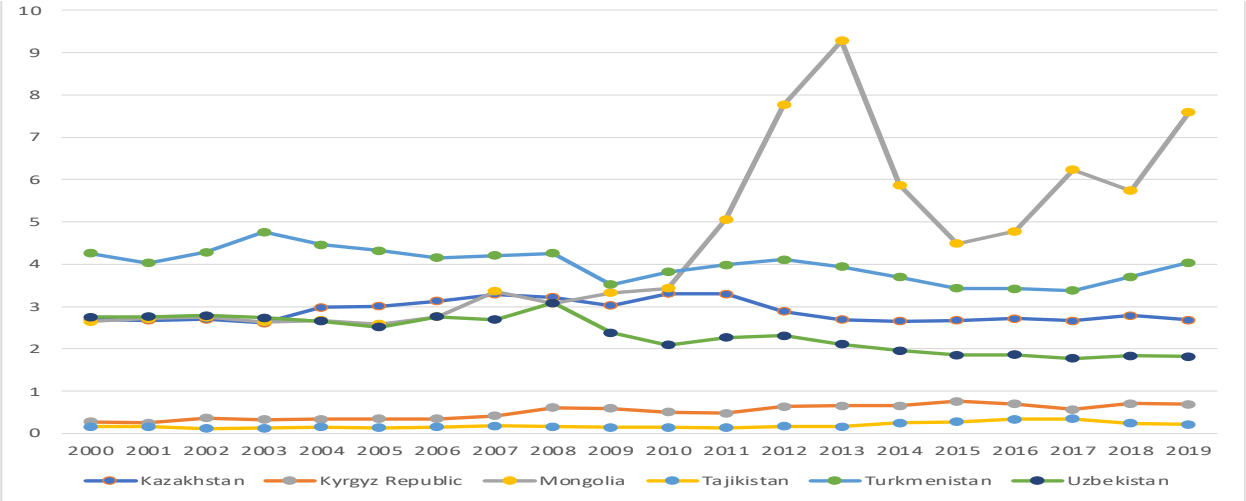
CA countries are reporting positively on achieving SDG 13: Climate Action, but some CA countries continue to contribute to high levels of CO_2 emissions. Tajikistan, Kyrgyzstan, and Uzbekistan report being close to achieving SDG 13, see Figure 1.5. Tajikistan and Kyrgyzstan have comparatively low CO_2 emissions from fuel combustion per electricity output (see Figure 1.6) due to their significant use of hydropower, giving them a lower baseline for emissions. Tajikistan and Kyrgyzstan are closer to achieving the long-term objective for this indicator (a value of 0). Kazakhstan, Turkmenistan and Mongolia demonstrated a downward trend in achieving SDG13 (Figure 1.5). Besides, Mongolia showed the highest level of CO_2 emissions, increasing after 2010. Whereas Uzbekistan has made notable progress towards reducing CO_2 emissions and almost halved the emissions from 2000-2019.

Figure 1.5 CA countries progress in achieving SDG13: Climate Action 2000-2022 in %.



Source: UCA (2023) Central Asian dataset on SDGs 2000-2022

Figure 1.6 CO_2 emissions from fuel combustion per total electricity output in CA countries, 2000-2019, in $MtCO_2$/TWh

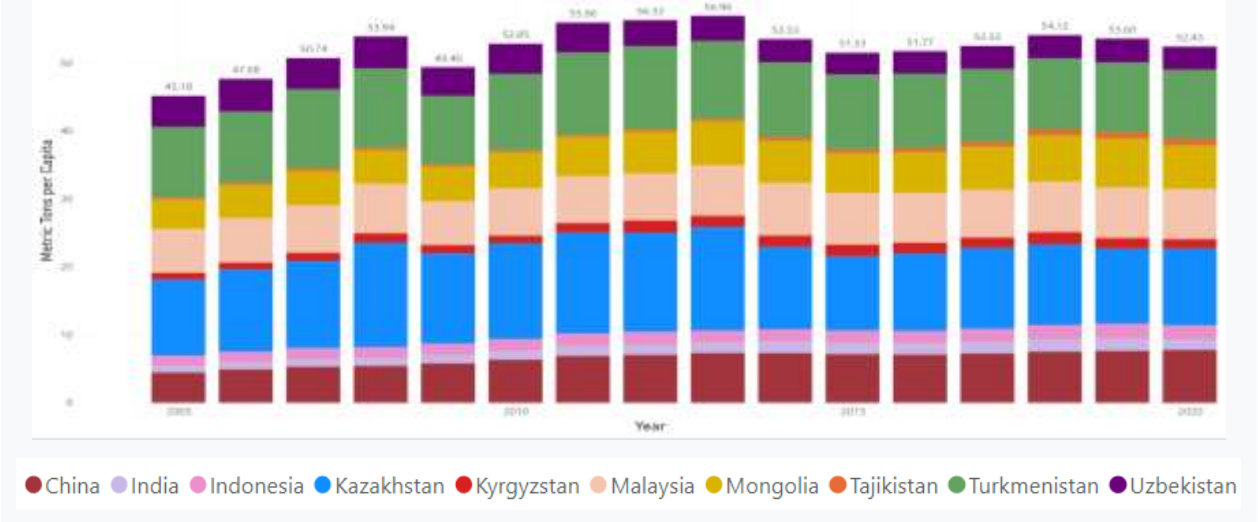


Source: UCA (2023) Central Asian dataset on SDGs 2000-2022

1.2 Contribution of transport to the greenhouse gas emission

The volume of CO2 emission in CA countries is higher than the world average, and energy intensity continues to grow. The volume of CO2 emissions in tons per capita in Kazakhstan and Turkmenistan is two times larger than in China and Malaysia. The contribution of Kyrgyzstan is almost like in India and Indonesia (Figure 1.7). According to ESCAP (2021), Central Asia's average regional energy intensity was 0.37 kilograms per unit of economic output, exceeding the global average of 0.3 kilograms per unit of economic output. Kyrgyzstan's and Tajikistan's CO2 emission intensities grew between 2011 and 2018. In 2018, Turkmenistan had the highest CO2 emission intensity relative to GDP in the region, standing at 0.83 kilograms per unit of economic output, followed by Uzbekistan and Kazakhstan at 0.48 and 0.47 kilograms per unit of economic output, respectively.

Figure 1.7 CO_2 emissions for CA countries and other selected Asian countries (China, India, Indonesia, and Malaysia), in 2005, 2010, 2015, and 2020



Source: World Bank (2023): The World Development Indicators

The transport sector's energy consumption is growing, and it is a significant contributor to carbon emissions in CA countries. Within the transport sector, road transport was the largest emitter in CA countries, contributing around 80% of total transport-related CO2 emissions in 2015 (ITF, 2022). The transport sector also plays a significant role in energy consumption and greenhouse gas emissions across all study countries, with notable increases observed in some regions over specific time periods. The share of transport emissions in the energy sectors of study countries are as follows:

- Energy consumption in Kazakhstan's transport sector almost doubled in 10 years, from 4.75 million tonnes of oil equivalent (toe) in 2010 to 7.44 million in 2020 (Stat.gov.kz, 2023). If in 2010, the Kazakhstani transport sector made up only 7% of the overall country's energy consumption, in 2020, it reached 11%. The transport sector energy intensity of GDP was 0.40 (toe/thousand USD in 2000 price) in 2010 and became 0.48 in 2020.
- In Kyrgyzstan, the transport sector's share in the total GHG emissions in the energy sector increased from one-fourth in 2008 to one-half in 2018 (UNFCC, 2021a).In Mongolia, the transport sector's contribution to total greenhouse gas (GHG) emissions in the energy sector grew from 19% in 1991 to 21% in 2014 (UNFCCC, 2017).
- In Tajikistan, the transport sector's share in the total GHG emissions in the energy sector remained relatively stable at 10% during 2004-2014 (UNFCCC, 2018).
- Transport emissions in Turkmenistan accounted for 13% of the total GHG emissions in 2010, and increased by 50% from 4922.16 Gg (CO2-eq.) in 2000 to 7040.72 Gg (CO2-eq.) in 2010 (UNFCC, 2022b).
- In Uzbekistan, transport made up 16.5% of the total GHG emissions of the energy sector in 2017 (UNFCC, 2021b).

Road transport is the main contributor to GHG emissions in all study countries, and its input in the transport sector's carbon footprint is growing:

- During 2016-2020, 84-86% of GHG emissions in the transport sector in Kazakhstan came from road transport (UNFCC, 2022a). GHG from road transport in Kazakhstan has increased (by 12.3%) in 2019 compared to 2016.
- The CO2 emissions from road transport in Kyrgyzstan increased by 54.17% in 2018 compared to 1990 (UNFCC, 2021a).
- The CO2 emissions from road transport in Mongolia increased 2.2 times in 2014 compared to 1991 (UNFCCC, 2017).
- Road transport contributed to over 90% of transport emissions in Turkmenistan and Tajikistan (UNFCC, 2022b; UNFCCC, 2018).
- During 2012-2017, the CO2 emissions from transport in Uzbekistan increased by 11%, mainly due to the growth of private cars (UNFCC, 2021b).

The GHG emissions from rail and air transport are relatively low but continue to grow due to increasing cargo and passenger transportation demand in most CA countries. In Kazakhstan, the contribution of domestic aviation and rail transport in 2019 national GHG emissions amounted to 4.58% and 5.56%. However, there has been an increase in GHG emissions from rail transport in Kazakhstan by 15.3% during 2016-2020, which could be associated with the depreciation of the fleet of shunting locomotives (UNFCC, 2022a). The GHG in domestic aviation in Kazakhstan increased by 27% in 2020 compared to 2016 due to increased cargo and passenger transport by air (UNFCC, 2022a). In Mongolia, the share of civil aviation in the total GHG

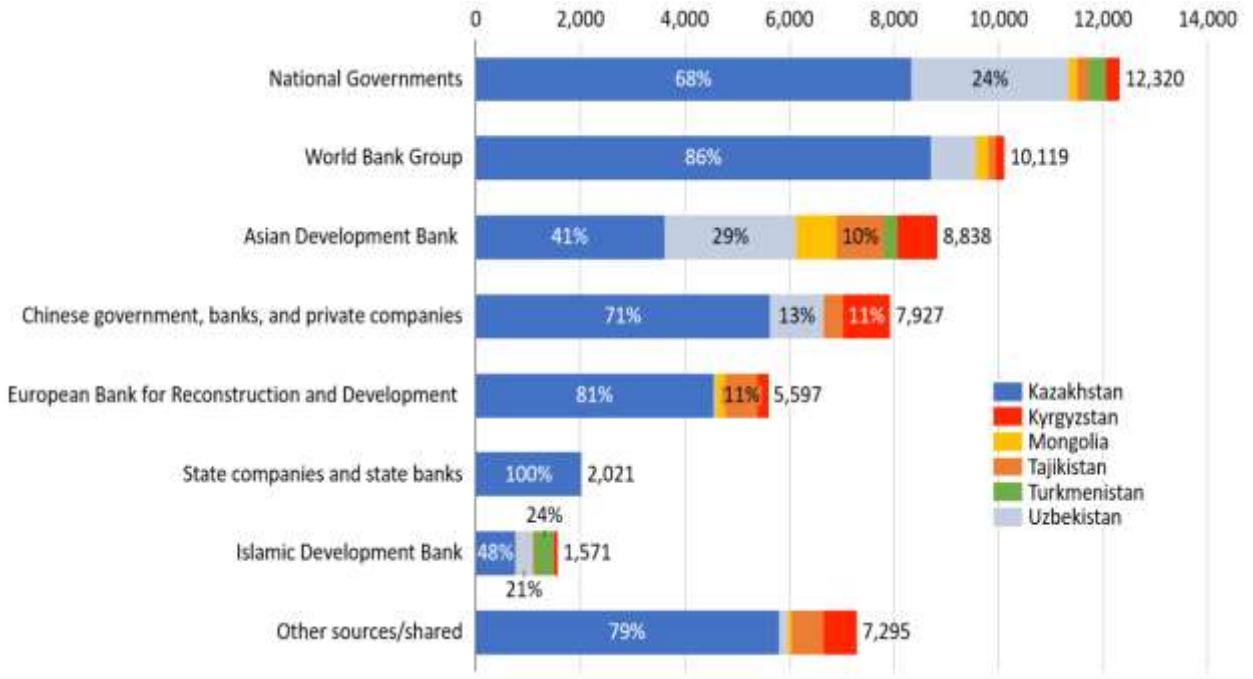
emissions of transport within the energy sector slightly decreased from 3% in 1991 to 2% in 2014 (UNFCC, 2017). The share of railways' emissions also decreased from 19.6% in 1991 to 14% in 2014. In Tajikistan, the share of railways in the total GHG emissions of transport within the energy sector in 2014 made up 11% (UNFCC, 2018).

2. Investment in transport infrastructure

2.1 Main investment trends in transport infrastructure

Not all CA countries have the fiscal capacity to invest in transport infrastructure and continue to depend on external funding. Samad and Abbas (2020) assert that while physical infrastructure is gradually improving in the CA region, its development could be better, with Tajikistan and Kyrgyzstan working to match the rest of the region. For 15 years (2008-2022), CA's national governments and state organisations allocated $12.3 billion to implement transport projects, making one-fourth of all investments (Figure 2.1). Kazakhstan (68% of the total) and Uzbekistan (24%), having larger territories and higher GDPs, are leading in public investment in transport infrastructure. Turkmenistan's total public investment was only 3%. Kyrgyzstan and Tajikistan's public sectors contributed by 2% and Mongolia's by 1%, underscoring their dependence on external aid and funding to develop the transport sector (Figure 2.1). The World Bank (18.5%), the Asian Development Bank (ADB) (14.6%), Chinese government and companies (14.4%) have played crucial roles in funding transport projects, making up almost half of all transport investments in the CA region during the last 15 years.

Figure 2.1 Investment in transport projects in CA countries in 2008-2022 by source of funding and countries, in million USD.



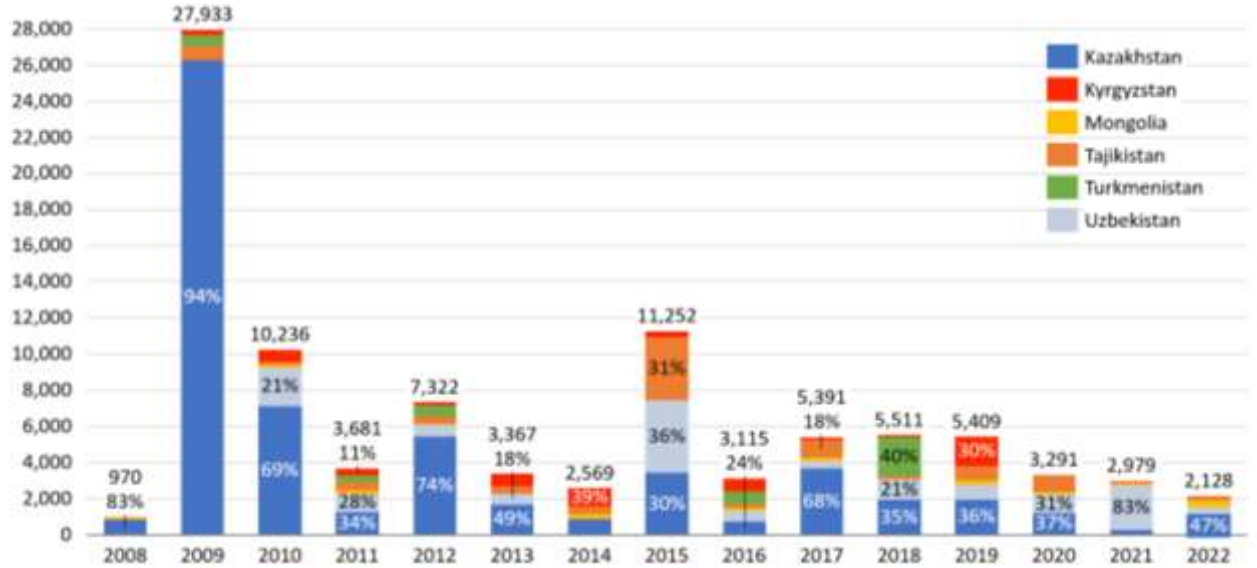
Source: UCA (2023) Central Asian dataset of infrastructure projects 2008-2022

In CA countries like Kyrgyzstan, Tajikistan, and Mongolia, development banks and China's investment in transport projects is much higher than allocated public funding. Kyrgyzstan undertook a significant endeavor in 2014 and 2016 to construct an alternative North-South Road, with substantial funding from the Chinese Exim Bank. Kyrgyzstan also constructed CAREC

Corridors 1 and 3, with primary investments occurring in 2013, 2016, and 2018, predominantly supported by the principal investor, ADB. In Tajikistan, projects focusing on CAREC Corridors 2, 3, and 5 saw significant investments from ADB and the European Bank for Reconstruction and Development (EBRD) in 2019. Among the most notable projects in Turkmenistan, the Construction of the Bereket–Etrek–Turkmenistan–Iran Border Railway in 2009 stood out with its primary investment from the Islamic Development Bank (IDB). Also significant was the North–South Railway Project in 2010 and 2011, primarily financed by ADB. In Mongolia, prominent projects include the Ulaanbaatar Darkhan Road in 2022, predominantly financed by EBRD, and the Regional Road Development and Maintenance Project in 2019, mainly funded by ADB.

Investment flow in transport is unstable and mainly associated with a few transit development projects. The investment volumes in transport projects in CA countries have experienced significant fluctuations over the past fifteen years. There was a period of substantial investment of $27 billion in 2009 and $11.3 billion in 2015, followed up by considerable drops of $2-2.5 billion in 2014 and 2022, with occasional minor increases in between, ranging from about $0.5 billion to $3,8 billion per year (Figure 2.2). A significant increase in investment in 2009 was primarily fuelled by the implementation of the Kazakhstani section of the Central Asia Regional Economic Cooperation (CAREC) corridor[3] and the Western Europe-Western China corridor[4] project, mainly funded by the national government of Kazakhstan and a range of international banks, including World Bank, ADB, IDB and EBRD. The Pap-Angren Railway[5] construction in Uzbekistan primarily drove a significant rise in investment volumes in 2015, funded by the national government, China's Exim Bank, and the World Bank.

Figure 2.2 Dynamics of investment in transport projects in Central Asian countries for 15 years by countries, in million USD.



Source: UCA (2023) Central Asian dataset of infrastructure projects 2008-2022

[3] A highway within CAREC Corridor 1 - the most active of the six - links Europe to East Asia, traversing the Russian Federation border to the People's Republic of China via Kazakhstan and the Kyrgyz Republic.
[4] Especially Almaty-Khorgos Section of the Western Europe-Western China road corridor, which extends from the South China Sea (Lyanyungan) to the Baltic Sea (Saint Petersburg).
[5] The Angren-Pap line is 123 kilometres long, crossing high mountainous areas, including areas with an elevation above 2000 meters.

Central Asian (CA) countries underinvest in transport infrastructure development. Over the past 15 years (2008-2022), the total volume of investments in the transport infrastructure of the CA countries amounted to only $55 billion, an average of $3.6 billion per year, which is six times less than South Korea. According to OECD (2023) data, the annual investment in transport infrastructure in South Korea is $22 billion. The recent EBRD (2023) study identified that the current investment gap in transport infrastructure development in the CA countries is around $20 billion. Samad and Abbas (2020) estimated that to achieve the established national goals, the CA and Caucasus region requires an additional investment of $26 trillion during 2016–2030, or $1.7 trillion per year, to scale up infrastructure development, including transport. The current declining CA trend in transport investment signals an expected further increase in the investment gap between ambitious transport infrastructure development plans and available funding (see section 3).

2.2 Main challenges for the development of sustainable transport infrastructure

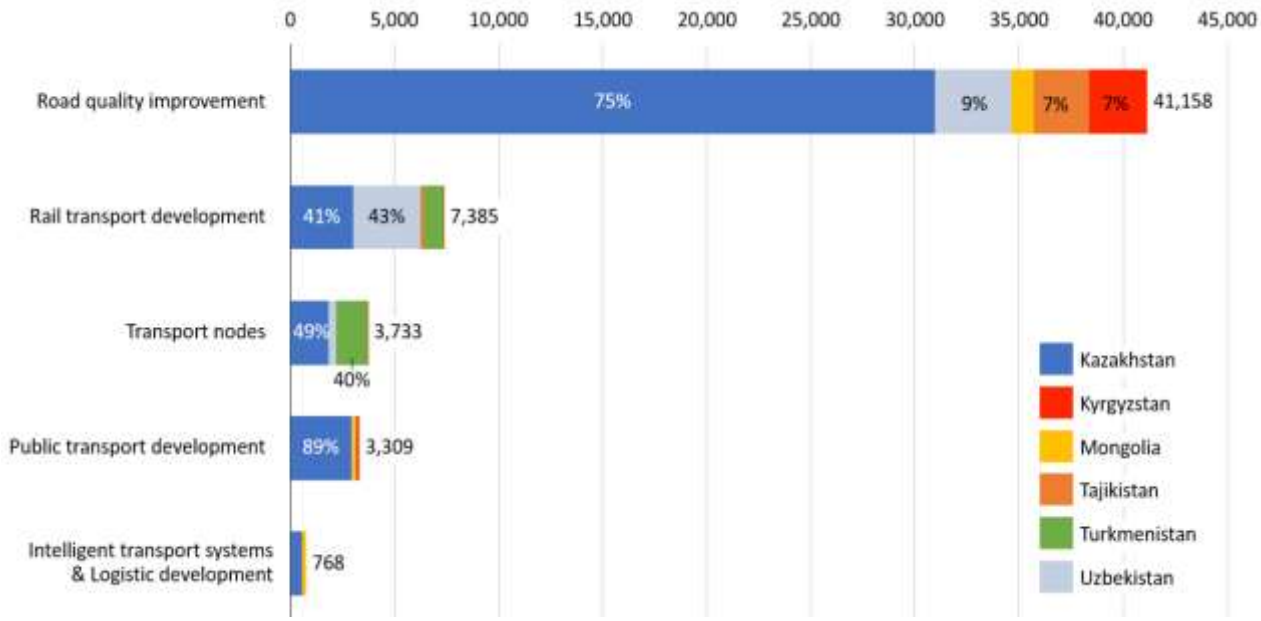
Underinvestment in transport infrastructure does not allow CA countries to develop transport and benefit from participation in global trade. Road and rail networks are vital in bolstering economic activities in landlocked CA economies by connecting markets and enhancing efficiency (Yoshino et al., 2021). However, many studies point out the technical and operational shortcomings of Central Asian roads, which are in poor condition, overloaded and ill-equipped for transporting large cargoes (FAO, 2017; Lezhava, 2017; Azhgaliyeva & Kalyuzhnova, 2021). Pomfret (2019) also asserted that the significant trade costs in the CA region could be partly due to the low-quality physical infrastructure. IBRD and World Bank (2018) reported that exporting from Kazakhstan required about $700 and 286 hours for each shipment in 2017, while exporting goods from developed OECD countries typically cost around $200 and took 15 hours per shipment. According to ITF (2019)[6] Central Asian countries have a connectivity gap that is around 50% of Germany's, one of the top performers, which affects their ability to integrate into global value chains. For example, a manufacturer in Kazakhstan must cover over 4,000 kilometers to reach 20% of the global GDP, whereas manufacturers in Germany or the United States only need to cover half that distance. The logistical costs of exporting goods from CA, including transport costs, constitute a large share of the final cost of exporting products, amounting to 70-80% of the value of exported products (Alymbekov, 2021).

CA countries' investment in improving road quality is significant but limited to funding highways forming international transport corridors, excluding enhancing regional and local roads. Over the 15 years, the primary investment in transport projects in CA countries went on improving road quality along the main transport corridors, which constitutes approximately 70% of the total investment ($42.2 billion) (Figure 2.3). The countries of Kyrgyzstan (99%), Tajikistan (91%), Kazakhstan (79%), and Mongolia (75%) demonstrate a substantial focus on road quality improvement (Figure 2.3). In comparison, Uzbekistan's investment fell just below 50%, and Turkmenistan did not invest in this type of project. The development of transport corridors, such as the North-South and East-West transport corridors, significantly drives road infrastructure projects forward. However, more could be done to improve the regional transport infrastructure to link local producers to these transport corridors (ITF, 2019, p.9). The road density (28 kilometres per 100 square kilometres) in the CA region is still significantly lower than in South and East Asia (Yoshino et al., 2021). The process of local road construction is lengthy and complicated by the

[6] International Transport Forum (ITF) (2019). Enhancing Connectivity and Freight in Central Asia. OECD Publishing.

existing gap in regional and local development planning and management. For example, the construction of the BAKAD bypass road in Kazakhstan took more than ten years due to the local government's inability to use locally available planning and regulations to reserve the planned land for it (Junussova, 2020).

Figure 2.3 Distribution of the total investment by main types of transport projects in Central Asian countries for 15 years (2008-2022) by countries, in million USD



Source: UCA (2023) Central Asian dataset of infrastructure projects 2008-2022

Transformation of CA highways into trade corridors demands better road quality and safety. Due to the low quality of construction and lack of adequate road maintenance in CA countries, new roads became old very fast. For example, Kazakhstan invested $5.6 billion to renovate the road along the Europe-China transit corridor called Western Europe and Western China (WE-WC) (Szabolcs, 2022). However, only a year after the road construction, due to poor quality of construction, the road surface had to undergo repairs due to cracks and potholes (NIITK, 2020). The inadequate road quality and insufficient installation of safety equipment did not allow the WE-WC corridor to function at its planned capacity due to the reduced traffic speeds and caused road accidents (Taisarinova, Loprencipe, & Junussova, 2020). Safety is crucial in trade logistics when transport companies choose the optimal route. Using low-quality roads accelerates the users' costs due to the high wear and tear of vehicles transporting goods and raises the risk of road accidents. One important factor causing rapid road degradation is truck overloading that requires enforcing restrictions alongside improved construction and maintenance practices (PrimeMinister.kz, 2024).

Underinvestment in trade facilitation infrastructure like transport nodes, border crossings, logistics and digitalisation continues to limit regional connectivity. CA countries invest a small amount in developing transport nodes (around $4 billion or 7% of the total investments) and underinvest in digitalisation and logistics development. Mongolia has dedicated a significant portion of its investment towards logistics development (14.7% of its total transport investment). Kazakhstan stands out as the only country in the region that has allocated some funds to the development of intelligent transport systems (ITS) (1.4% of the country's total investment in transport). Turkmenistan primarily emphasised the development of transport nodes, investing $1.5 billion or 61% of the country's total investment in transportation. The substantial investment

was tied to the Turkmenbashy port construction project completed in 2018. Other study countries made comparatively smaller investments in transport nodes, with Tajikistan contributing $18.4 million (13.2% of the country's total investment in transport), Uzbekistan $345 million (4.7%), Kazakhstan $1.8 billion (4.6%), and Kyrgyzstan $25.7 million (4.5%).

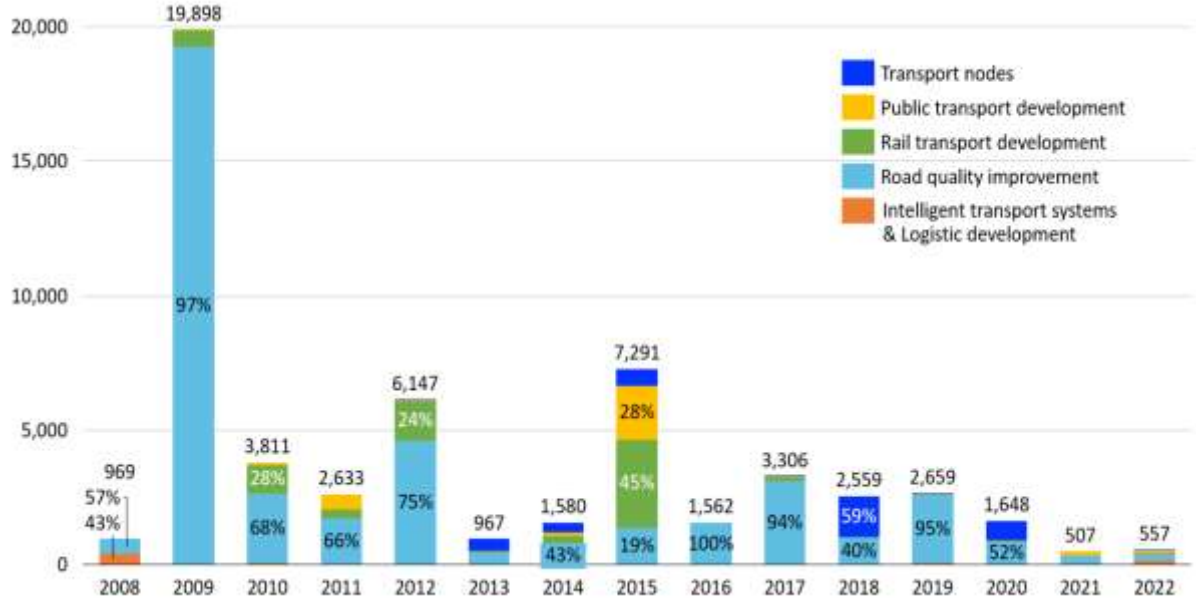
2.3 Contribution of transport projects to decreasing carbon emissions

CA countries' overemphasis on road construction without enough attention to road quality and maintenance may lock in carbon emissions from private vehicles. The poor quality of roads in CA countries usually leads to higher fuel consumption and carbon emissions as more energy is required to overcome the increased resistance of vehicles overpassing potholes and bumps. Ultimately, a better road surface can optimise fuel efficiency and overall vehicle energy efficiency in the short term. However, there is high underinvestment in road maintenance (less than 1%), traffic management and logistics (less than 1%), and electrification of private automobile transport (less than 1%). According to Lezhava (2017), about 60% of roads in Uzbekistan require rehabilitation due to ageing, while in Tajikistan, 80% of roads built before the 1970s are in poor condition due to insufficient maintenance. Junussova et al. (2023) argue that CA local governments lack capacities to develop and maintain transport infrastructure. Therefore, in the long run, road development without strategic actions for improving the quality of road planning, construction, and maintenance, enhancing traffic management, logistics and electrification of private automobile transport may lead to further growth of private cars, congestions, and increased carbon emissions.

CA countries' investment in cargo railways is the second priority after road development. In 2015, the CA investment focus shifted from road to cargo railway development ($7.4 billion) (Figure 2.3). Uzbekistan has placed significant emphasis on the development of railway transport; almost half of the total investment allocated to this type of project during the last 15 years. Turkmenistan is actively investing in expanding and enhancing railway transport infrastructure (61%); for example, the railway length doubled from 3,181 in 2007 to 7,680 kilometres in 2017 (World Bank, 2019). In contrast, Kazakhstan (8%) and Tajikistan (6%) have comparatively lower levels of investment in railway development, while Kyrgyzstan and Mongolia have small shares, each below 1%. The length of the railways in Uzbekistan and Kazakhstan grew by about 10%-12% over a decade (2007-2017) and reached 4,714 kilometres and 16,040 kilometers respectively. The rail transport development mainly aims to support cargo flow along the international transport corridors. The highest peak of investment in 2015 is associated with the launch of the Angren-Pap railway line, which represents a milestone project between China and Uzbekistan built under the Belt and Road Initiative (East-West transport corridor).

Due to challenging mountain terrain, Kyrgyzstan and Tajikistan have less developed rail networks (Levystone, 2022). The Central Asian railway infrastructure with a general north-south orientation was built by the Soviet Union (Högselius, 2022). The trains from China and Iran to Kazakhstan and Turkmenistan require bogie changes or wagon transfers because of the difference between the track gauges of 1520 mm of CA countries and neighbouring nations using 1435 mm tracks (Otsuka, 2002). Other key rail system challenges include limited connectivity with other modes of transport, a focus on low-value bulk goods, physical bottlenecks at borders, and unsatisfactory rolling stock (CAREC, 2022). All these factors require additional adjustments to the adaptation of the rail infrastructure in CA and targeted investments to strengthen rail as the regional freight backbone.

Figure 2.3 Investment by main types of transport projects in Central Asian countries for 15 years (2008-2022), in million USD



Source: UCA (2023) Central Asian dataset of infrastructure projects 2008-2022

Electrification of the railways in CA could be a promising opportunity for decarbonising the transport sector. CA countries electrified half of their railway, 54% of the country network in Uzbekistan (ADB, 2021) and 40% in Kazakhstan (Medeubaeva, 2019). Kyrgyzstan lacks electrified railway sections, relying solely on diesel locomotive traction, and its railway length is 14.5 times shorter than Uzbekistan's, neglecting many areas, especially mountainous regions (Pantograph, 2022). Tajikistan's railway network runs through the country's northern and western parts and consists of a non-electrified single-track line four times shorter than Uzbekistan's (CAREC, 2021). In 2021, Tajikistan and Uzbekistan governments committed to electrifying the railway line, linking the Uzbek cities of Bekobod and Kokand to the Tajik city of Konibod (Kun.uz, 2021).

In some CA countries, electrified transport does not work on clean energy consumption, creating a new carbon emissions trap. Constructing an electrified railway network and promoting the use of electrified private and public transport in CA countries may better contribute to decarbonization efforts if there is a reduced reliance on fossil fuels and better use of cleaner energy for transportation. Electric transport have lower carbon emissions when powered by clean energy sources. For example, Kazakhstan's electricity generation remains dependent on fossil fuels (87% in 2023) while Tajikistan's power mostly comes from hydropower (92% in 2023). Consequently, the operation of electrified transport modes in Kazakhstan causes decreased carbon emissions in regions located along the transport route and increased carbon emissions in the coal mining and power-generating regions. For example, in the case of the Almaty region, instead of using locally available clean solar power, the government funded the construction of a new power transmission line from northern coal-based electricity producers to supply southern regions, including electricity supply for an electrified railway line (Temirgaliyeva & Junussova, 2020). CA countries' energy power systems are in a state of disrepair, marked by significant losses and insufficient capacity to meet the demands of the rapidly growing populations (Sabyrbekov et al., 2023). The unreliability of energy systems in CA poses a significant constraint on the electrification of railroads in the region.

The development of transport nodes, logistics and digitalisation could be promising solution for decreasing transport and logistic costs and increasing energy efficiency of the transport sector. A good combination of transport node development with digitalisation and logistics can contribute considerably to CA's decarbonisation of the transport sector. Improved logistic and digitalisation help reduce carbon emissions and enhance the safety and quality of cargo and passenger transport by optimising transport routes and fuel usage, reducing traffic congestion and waiting time with turned-one engines. For example, the current congestion and high levels of carbon emissions at the border-crossing points may be avoided by better integrating digitalisation and logistics. The best illustration of the importance of a good combination of ITS and logistics is Kazakhstan's recently introduced electronic queue system. When the system was introduced, it did not allow separate cargo and passenger transport flows, putting trucks, private cars and motorbikes on one waiting list, which caused longer turns for cargo trucks at the borders.

The development of public transport is mainly concentrated in urban areas, whereas the development of regional public transport remains overlooked. One of the most significant investments in the advancement of public transport was directed towards the Ulaanbaatar Sustainable Urban Transport Project in 2021, with a funding of $100 million. Another considerable investment was related to the development of Sustainable Transport in Almaty City ($81.4 million in 2011), focused on mitigating the increase in GHG emissions associated with transportation in the City of Almaty. The Urban Transport Electrification Project in Kyrgyzstan ($59.6 million in 2021) has initiated a long-term transition towards a zero tailpipe-emission transport sector in Bishkek. Contemporary literature primarily emphasizes improving the environmental impact of urban public transportation, often overlooking challenges in suburban and rural areas (OECD, 2019). While green urban transport is essential (ESCAP, 2019; UNECE, 2019; World Bank and CAREC, 2022), a balanced approach addressing urban and regional needs is crucial for comprehensive and sustainable transport connectivity (UNCTAD, 2018). The main spots of carbon emissions in CA are entry points to cities. The underdevelopment of high-speed regional public transport systems makes all city commuters use their private cars to get to their jobs in cities and back, increasing the level of air pollution every morning and evening during the working weekday.

Summary of key findings

The analysis of the most recent 14-year (2008–2022) patterns in investments in the transport infrastructure development in Central Asian states demonstrates that:

- Some CA governments have limited budget capacity to invest in transport infrastructure and mainly rely on financial and technical assistance from development banks and China.
- The investment in transport infrastructure is not stable and mainly associated with constructing transit trade corridors.
- After 2020 investment in transport infrastructure declined to the lowest levels since 2008. CA governments need to allocate more financial resources to develop transport infrastructure and attract more private finance.

There are remaining critical challenges for the development of sustainable transport infrastructure in Central Asia:

- Underinvestment in transport infrastructure does not allow CA countries to develop transport and benefit from improved regional and internal sonnectivity ans a sustainable participation in global trade.
- Transforming CA highways into sustainable trade corridors demands better road quality and safety.

- CA countries' investment in improving road quality is significant but limited to funding highways forming international transport corridors, excluding enhancing regional and local roads.

The assessment of the potential contribution of transport projects to decreasing carbon emissions uncovered the following challenges and opportunities for transition to decarbonisation:

- CA countries' overemphasis on road infrastructure improvement may lock in carbon emissions from private vehicles because the development of public transport is mainly concentrated in urban areas, while the development of regional public transport is overlooked.
- CA countries' public investment in cargo railways is the second priority after road development and electrification of the railways in CA could be a promising opportunity for decarbonising the transport sector. However, in some CA countries, electrified railway transport does not work on clean energy consumption, creating a new carbon emissions trap.
- The development of transport nodes in CA countries could be better aligned with the development of logistics and digitalisation, playing an essential role in increasing the energy efficiency of the transport sector, in addition to economic benefits of integration and connection with foreign markets.

3. Policy environment for the decarbonisation of transport

In recent decades, the CA policy environment has evolved towards welcoming decarbonisation in the transport sector. Particularly, some CA strategic documents express specific steps towards reducing emissions within the transport sector (Table 3.1). Kyrgyzstan's government is at the early stage of adopting a national policy framework for considering climate change and the transition to a green economy. The government of Uzbekistan is studying ways of integrating climate actions on a strategic level and has started to build ground for a transition to a green economy. Tajikistan, Turkmenistan, and Mongolia leaders emphasised the need for climate change-related actions. Only Kazakhstan recently crafted its pivotal policy blueprint, the "Strategy for Achieving Carbon Neutrality of the Republic of Kazakhstan until 2060," but remains in the early stages of formulating detailed strategies and action plans. In other countries, decarbonization targets are scattered in separate documents.

CA country governments established ambitious decarbonisation goals, which require the attraction of additional financial resources, making its implementation conditional to external aid. To contribute to global climate actions and commit to implementing the Paris Agreement, CA country governments established greenhouse gas (GHG) emission reduction targets (Table 3.2). Most CA countries include ambitious targets of decreasing GHG from 15-45% in the Nationally Determined Contributions (NDC) and national development plans, highlighting the dependence of achieving these targets on global technical assistance and funding support. The transport sector in Central Asia is a significant source of GHG emissions due to its reliance on fossil fuels, including gasoline and diesel (ITF, 2022). Consequently, investment in the transport infrastructure plays a crucial role in determining the success of broader decarbonization efforts in most CA countries. According to their NDCs, sustainable transportation initiatives and adopting clean energy solutions are critical components of their strategies to meet these emissions reduction goals.

Table 3.1 Reviewed policy documents supporting decarbonization of transport in CA countries

Name of the policy document	Short title
Kazakhstan	
Strategy for achieving carbon neutrality of the Republic of Kazakhstan by 2060	KZ Decarbonisation 2060
Concept for the Development of Transport and Logistics Potential of the Republic of Kazakhstan until 2030	KZ Transport 2030
Concept for the Transition of the Republic of Kazakhstan to a Green Economy (until 2050)	KZ Green economy 2050
Approval of the Action Plan for the Increased Use of Natural Gas as Motor Fuel 2019-2022	KZ Natural gas 2019 – 2022
Updated Nationally Determined Contribution (2023)	KZ NDC
Kyrgyzstan	
The National Development Programme of the Kyrgyz Republic until 2026	KG NDP 2026
Concept for the Development of Road Transport in the Kyrgyz Republic 2020 - 2024	KG Road transport
Law of Kyrgyzstan on the Protection of Atmospheric Air	KG Law on atmosphere
Updated Nationally Determined Contribution (2021)	KG NDC
Uzbekistan	
Strategy on the transition of the Republic of Uzbekistan to a green economy for the period 2019-2030	UZ Green economy transition
Program for the transition to a green economy and green growth in the Republic of Uzbekistan until 2030	UZ Green economy 2030
Law of the Republic of Uzbekistan on transport	UZ Law on transport
Updated Nationally Determined Contribution (2021)	UZ NDC
Tajikistan	
Law to ensure environmental safety of road transport	TJ Law on environmental safety
State target programme for the development of the transport sector until 2025	TJ Transport 2025
National Climate Change Adaptation Strategy of the Republic of Tajikistan until 2030	TJ Climate change 2030
National development strategy of the Republic of Tajikistan for the period up to 2030	TJ NDS 2030
Updated Nationally Determined Contribution (2021)	TJ NDC
Turkmenistan	
Turkmenistan's National Strategy on Climate Change	TKM Climate change
Law of Turkmenistan on the Protection of Atmospheric Air	TKM Law on atmosphere
Turkmenistan Transport Diplomacy Development Programme 2022-2025	TKM Transport diplomacy 2022-2025
Nationally Determined Contribution (2022)	TKM NDC
Mongolia	
National Action Programme on Climate Change	MN Climate change
National green development policy (2014-2030)	MN Green development
Mongolia Sustainable Development Vision 2030	MN Vision 2030
Updated Nationally Determined Contribution (2020)	MN NDC

Table 3.2 Decarbonisation targets of CA countries

	Kazakhstan	Kyrgyzstan	Mongolia	Tajikistan	Turkmenistan	Uzbekistan
GHG emission reduction target by 2030	by 15 %	by 15.97%	by 22.7%	not exceed 60-70% of base year	by 20%	by 35% per unit of GDP
Conditional (international* and other support**)	by 25% by 2030*; reaching carbon neutrality by 2060*	by 36,61% by 2025*; by 43,62% by 2030*	by 27.2% by 2030**; by 44.9% by 2030**	not exceed 50-60% of base year by 2030*	-	-
Policy document	KZ Decarbonisation 2060; KZ NDC	KZ NDC	MN NDC	TJ NDC	TKM NDC	UZ NDC

CA countries plan to continue constructing and rehabilitating roads along main international corridors, electrifying railways, and developing new transport and logistic nodes (Table 3.3). In all CA countries, policies focus on enhancing and expanding transportation networks, encompassing roads, railways, and intelligent transport systems. These infrastructure enhancements aim to increase connectivity and efficiency, reducing travel delays and congestion. For instance, between 2021 and 2030, Mongolia aims to establish new transportation and logistics hubs, enhance international and domestic road networks, and finalize regional railroad construction. By 2030, Uzbekistan plans to design and develop new transport and logistics systems and expand road infrastructure. Tajikistan's plans up to 2030 include modernizing existing transport infrastructure and undertaking road and bridge reconstruction and construction. By 2040, Kyrgyzstan aims to rehabilitate and preserve highways, establish open and secure international transport corridors, and incorporate new road design and construction technologies.

Table 3.3 CA plans on the development of roads, railways, transport, and logistic nodes

Measure	Kazakhstan	Kyrgyzstan	Mongolia	Tajikistan	Turkmenistan	Uzbekistan
Reconstruction and rehabilitation of roads, improvement of roadside infrastructure on international road corridors	KZ Transport 2030	KG NDP 2026; KG Road transport	MN Vision 2030; MN Green development; MN Climate change	TJ Transport 2025; TJ Climate change 2030	TKM Transport Diplomacy 2022-2025	UZ Green economy transition
Electrification of railways	KZ Transport 2030	KG NDP 2026	MN Green development; MN Climate change		TKM Climate change	
Railway construction and modernization	KZ Transport 2030; KZ Decarbonisation 2060		MN Vision 2030; MN Climate change Program		TKM Climate change	
Development of new transport and logistics systems	KZ Transport 2030	KG NDP 2026; KG Road	MN Vision 2030; MN Green development	TJ NDS 2030; TJ Transport 2025		UZ Green economy transition

CA country policies emphasise the importance of promoting fuel-efficient vehicles and enhancing environmental standards to reach international environmentally friendly transport standards (Table 3.4). Remarkably, most CA nations have indicated their commitment

to implementing measures that facilitate the transition of the transport sector away from non-environmentally friendly fuels. These steps encompass adopting alternative and greener energy sources, including biofuels, promoting electric vehicles and railway electrification, and embracing modern energy-efficient transportation modes. This shift involves moving beyond traditional gasoline-based options and utilizing liquefied gas, hybrid vehicles powered by gasoline and electricity, electric vehicles, and more. Kazakhstan is also exploring opportunities to produce and use sustainable aviation fuel while emphasising the adoption of hydrogen fuels. Kazakhstan and Uzbekistan are the only nations that have outlined green investment measures as part of their respective Decarbonization 2060 and Green Economy 2030 strategies, particularly emphasising the transport sector. Kazakhstan and Mongolia are also exploring the use of hydrogen as a means for decarbonising local transport infrastructure.

Table 3.4 CA plans on the enhancing transport standards

Measure	Kazakhstan	Kyrgyzstan	Mongolia	Tajikistan	Turkmenistan	Uzbekistan
Ensuring environmental standards in transport sector including their alignment with international standards	KZ Transport 2030; KZ Decarbonisation 2060	KG Law on atmosphere; KG Road transport	MN Green development Policy; MN Vision 2030	TJ Law on environmental safety; TJ Transport 2025	TKM Law on atmosphere	UZ Law on transport; UZ Green economy transition
Promoting incentives and regulations for fuel-efficient vehicles	KZ Decarbonisation 2060; KZ Green economy 2050	KG NDP 2026; KG Road transport	MN Green development; MN Climate change	TJ Climate change 2030	TKM Climate change	
Incorporating the concept of green investment into investment policies and projects, particularly in the realm of green transportation.	KZ Decarbonisation 2060					UZ Green economy 2030

CA countries recognise the need to develop energy-efficient public transport, but not all countries equally promote the digitalisation of public transport. Countries like Uzbekistan and Turkmenistan are promoting public transport and the use of electric public buses. Tajikistan is also highlighting the need for the use of fuel-efficient public passenger vehicles. Mongolia also expanding and improving a diverse range of economically viable, secure, and convenient public transportation services aligned with customer needs. Meanwhile, Kazakhstan is the only country emphasising the development of suitable infrastructure for eco-friendly public transportation. Kyrgyzstan only plans to start the digitalisation of urban transportation systems that have been already implemented in Kazakhstan since 2013. Some of the common digitalisation initiatives introduced in both countries are special automated measuring devices, systems of traffic management, analysis and forecasting of climatic conditions, video monitoring and detection of traffic violations, etc.

Table 3.5 CA plans on the development of energy-efficient public transport

Measure	Kazakhstan	Kyrgyzstan	Mongolia	Tajikistan	Turkmenistan	Uzbekistan
Expanding and enhancing of environmentally friendly, high-capacity public transport modes (electric buses and trolleybuses) and developing efficient public transport systems in urban areas	KZ Transport 2030; KZ Decarbonisation 2060	KG Road transport; KG NDP 2026	MN Climate change; MN Green development	TJ Transport 2025	TKM Climate change	UZ Green economy transition
Facilitating the transition of the transportation sector to the utilization of high-quality and enhanced fuels (use of natural gas, biofuels and hydrogen)	KZ Decarbonisation 2060; KZ Transport 2030	KG Road transport	MN Climate change	TJ Transport 2025; TJ Law on environmental safety	TKM Climate change	UZ Green economy transition
Encouraging the public to switch to public passenger transport	KZ Transport 2030; KZ NDC	KG NDC	MN Climate change; MN NDC	TJ NDC	TKM NDC	UZ NDC
Intelligent transport systems	Digital Kazakhstan 2018-2022	KG NDP 2026				

Summary of key findings of expert interviews

None of the Central Asian (CA) countries have a clearly defined strategy for transitioning transport to decarbonisation. The above-reviewed policies create favourable ground for starting decarbonisation actions in the transport sector. However, during the expert interviews, representatives of the national governments and think tanks emphasised notable policy planning, evaluation and implementation challenges requiring the CA government's attention. Although national strategies and programs of CA countries include some decarbonisation actions such as using low-carbon fuels, promoting electric mobility, and expanding public transport, policies do not establish any specific, measurable objectives for decreasing carbon emissions or minimising carbon footprint in the transport sector. The pursuit of decarbonising the transport sector in CA is in its nascent phase, characterised by broad objectives, ambitious regulatory reforms, and a need for strategic and systematic evaluation, and implementation capacities and actions.

Political instability, continuing reforms, and changes in the CA governments' organisational structures are leading to the shortage of institutional memory, high rotation, and staff flow that negatively affect the planning and implementation of decarbonisation reforms. Political

instability in Kyrgyzstan did not allow ministries to create a workable analytical foundation, forecast future resources and demand, or at least feasible scenario projection of transport development for the next three years, which became a severe obstacle for attracting foreign investors. In Mongolia, a ministry can exist for only a year or even less, which is too short for meaningful engagement in understanding and implementing the assigned policies, activities, and projects. Kazakhstan has the youngest Ministry of Transport, which was created in September 2023 by separating the Transport Committees from the Ministry of Investments and Development.

CA countries still need a well-developed monitoring and evaluation system, indicators to measure the impact of carbon reduction measures, and open data and information sharing among the CA countries. Without a robust monitoring and evaluation framework, CA countries are unable to understand the dynamics of carbon emissions in the transport sector, making it challenging to discern the efficacy of planned and implemented measures. As stated by experts, none of the CA countries have yet established a sustainable ongoing data collection process for planning, monitoring, and evaluating decarbonisation in the transport sector. Existing measurements, indicator development, and reporting are neither coherent nor compatible. There are some actions to measure CO2 emissions in CA cities. For example, the Kazakhstan Hydrometeorological Service ("Kazgidromet") monitors air pollution in 34 major cities and areas with intensive industrial activity. However, the number and location of existing stations are insufficient for a representative analysis of air pollution explicitly caused by transport. Kazakhstan leads in open government data, while other Central Asian countries lag behind with average to low levels of open data and information systems development, adding to the overall complexity of the situation (Tazhiyev, 2021).

CA governments continue to conduct sector-specific planning with decarbonisation actions in the transport sector that are not aligned with energy and environmental policies. Most decarbonisation and climate change actions in the transport sector in CA countries continue to be re-addressed to the government actors responsible for environmental protection. Due to poor coordination among ministries, the legislative frameworks governing transport, environmental protection, and investment are not yet harmonised to attract private investment. According to the example provided by the expert from Kyrgyzstan, there are remaining conflicts and gaps in the law on investment, the law on transport, the law on public-private partnership and environmental code that need to be addressed to incentivise private transport operators to contribute to reaching carbon neutrality. As stated by the expert from Kazakhstan, despite many efforts towards decarbonising international trade, the lack of adequate coordination among the country ministries continues to be a significant obstacle to developing green border points.

The CA countries lack economic capacities and nationally available fiscal resources to finance the implementation of planned decarbonisation actions. CA countries are experiencing growing inflation, and their economies are slowing down under the crisis that started during the COVID-19 impact and accelerated by the Russian war in Ukraine. Despite the growing social burden on the country's budget, the Kazakhstan government has optimistically set an objective of achieving carbon neutrality by 2060, estimating the required annual investment at US$4.2 billion in low-carbon technologies for the transport sector alone. This financial demand juxtaposes the 2022 investment of US$3.4 billion in Kazakhstan's transport and logistics sector (including foreign borrowings) (Statistic Bureau, 2022), underlining the considerable economic commitment required to align with their decarbonisation aspirations**.** Experts from Tajikistan, Mongolia, and Kyrgyzstan pointed out that CA governments do not hide that their achievements are conditional and rely exclusively on external borrowings and financial aid. Kyrgyzstan intends to launch the production of commercial electric vehicles, passenger buses (gas-fuelled), and electric buses,

which require more than $125 million of private and donor funding for 2022-2024 (Kyrgyz Government, 2026).

Transport decarbonisation in CA demands considerable investment in developing human capacity, such as skilled project managers, transport experts, and maintenance professionals. Most CA experts agree that the current planning, implementation, and operation of transport projects in CA countries exhibit low efficiency. Unfortunately, poor attention continues to be paid to the long-term negative social and environmental impacts in planning and implementing transport projects in most CA countries. Interviewed experts from Kyrgyzstan, Tajikistan, and Mongolia raised concerns about the need for project management skills among the government representatives responsible for transport projects. According to an expert from Mongolia, most large-scale infrastructure projects are planned and constructed by foreign consultants without adequate engagement and cooperation with local experts. At the same time, foreign experts spend too much time understanding the local situation and do not contribute to developing local technical capacities, leading to poor control over implementing and maintaining public transport infrastructure. All experts emphasized the need for more qualified specialists, civil and IT engineers, and transport and logistics experts to implement the ambitious decarbonisation plans.

Low public awareness and business engagement lead to low prioritisation of decarbonisation projects in the CA society. There is low awareness about climate change and reaching carbon neutrality in public and private domains of most CA countries' governments. All experts agreed that none of the CA governments run public awareness campaigns or use schools or media to make people concerned about the environmental impact and decarbonisation of the transport sector. As stated by the experts from Kazakhstan and Uzbekistan, the CA governments continue to emphasise the importance of economic growth, often conflicting with required action for transitioning to environmentally friendly development. Experts from Kyrgyzstan and Uzbekistan pointed out that CA governments do nothing to engage the private sector in co-implementing decarbonisation policies. At the same time, private actors benefit from the government-started decarbonisation steps and the inefficiency of their implementation. As mentioned by one of the experts, Kazakhstani private companies found developing charging stations for electric cars profitable because of the growing number of electric cars and the high difference in tariffs for purchasing and selling electricity. The Kazakhstan government regulates electricity tariffs to keep them affordable for low-income residents, but not the price of charging an electric car at a private station.

The underdevelopment of transport and other related infrastructure remains the critical obstacle hindering expected benefits from decarbonisation actions. Most experts noted that there needs to be more consistency in the decarbonisation policy actions and development of the required supporting infrastructure. For example, some CA governments created unique conditions for increasing the number of electric cars in the local markets. However, CA governments did not prepare the transport infrastructure by improving road quality and safety, developing charging infrastructure, and creating infrastructure to store or reuse new types of hazardous waste like lithium-ion batteries. As highlighted by an expert from Tajikistan, the average lifespan of electric car batteries is 10-20 years, whereas the country still needs to have adequate waste management infrastructure or a clear strategy of what should be done with old used batteries. Experts from Kazakhstan, Kyrgyzstan, and Uzbekistan found that the quality of transport infrastructure in CA is poor not only because of underinvestment but mainly due to corruption and the inefficient use of public finance**.** Poor quality regional roads or their absence do not allow local businesses to benefit from participation in international trade. As reported by the Ministry of Industry and Infrastructural Development of Kazakhstan, there is notable public dissatisfaction with ongoing

road repair works, evident from various online videos and photos showing works being conducted outside of schedule and against regulations (PrimeMinister.kz, 2023). Due to malfunctioning CA border crossings, many tracks stay in turn to pass the customs check and pollute the surrounding environment with carbon and other emissions.

Most public transport development measures in CA aim to improve conditions in the country's metropolitan and large cities. As highlighted by the expert from Tajikistan, the disproportionate emphasis on urban areas raises concerns about the inclusivity and equitable distribution of the transport decarbonisation benefits across diverse geographical settings. Experts from Kazakhstan and Uzbekistan confirmed that measures on energy-efficient public transport and private vehicles are focused exclusively on capital cities and some other large cities. Neglecting the regions may exacerbate disparities in environmental quality and sustainable development and hinder the overall effectiveness of decarbonisation initiatives.

4. Policy Recommendations

CA governments can achieve more if they jointly work on regional and country-specific strategies guiding them toward achieving a net-zero status in an integrated manner, merging decarbonisation of transport with clean energy transition, and enhancing the quality of living environment. CA government should elaborate less ambitious but pre-assessed feasible strategies supported by specific and measurable objectives for reducing carbon emissions and minimising the carbon footprint, outlining a roadmap for achieving these targets. Decarbonisation strategies should be a generic part of the national transport development plans and aligned with broader economic and development goals, ensuring a systematic approach to addressing transport infrastructure gaps. There is a need to create policy frameworks incorporating clear timelines, specific milestones, and performance indicators to guide the systematic implementation of decarbonisation actions. The starting point could be working together to discuss new trade routes like Middle Corridor. CA government should prioritise the development of multimodal transport systems and enhance connectivity within and beyond national borders, facilitate efficient movement of goods and people, and promote sustainable participation of CA countries in global trade.

The CA governments should start collective actions in preparation for a long-term transition to decarbonisation by making strategic policy commitments to enhancing monitoring and reporting mechanisms. CA governments could merge available expert capacities to create robust and evidence-based monitoring and reporting mechanisms to track progress toward established decarbonisation goals, as well as implement regular transparent assessments and evaluations to measure policies' effectiveness and identify improvement areas. CA countries are at the early planning and conceptualisation stages of decarbonisation efforts. Therefore, **i**t is essential to set quantifiable targets and common indicators to monitor and evaluate the progress. By establishing a regular review process for decarbonisation policies, CA countries could continuously update strategies based on changing circumstances, technological advancements, and emerging opportunities. It will ensure that the decarbonisation policies of CA countries remain adaptive and effective over time.

While establishing monitoring and evaluation processes, CA should enhance their air quality data which underpins the quality of a living environment. It is crucial to support the strengthening of fuel quality improvement by introducing data collection infrastructure for measuring the change in the quality of the living environment. CA countries should stop using the prescription standards such as maximum allowable concentration established during the Soviet times. Introducing better air quality standards aligned with the latest scientific advancements or internationally accepted standards is essential. The reform should encompass the shift from the air pollution indexes to contemporary air quality indexes, informed by real-time national and sub-

national assessments of air pollution impacts. Besides, data collection infrastructure to monitor environmental indicators should cover not only large cities but also mining regions and towns, logistic hubs, border crossings and transport corridors.

Policy harmonisation across sectors is a crucial precondition for implementing the planned decarbonisation actions in all CA countries. There is a need for a more integrated approach to legal frameworks, ensuring consistency and coherence across different sectors to promote a conducive environment for investment. In the absence of such harmony, navigating the legal landscape becomes complex, potentially hindering the effectiveness of policies and impeding the economy's overall growth. CA policies should address the gradual transition for phasing out of fossil fuels by stronger regulations and incentives across the transport, energy, and industry sectors. The decarbonisation of transport is tightly dependent on the decarbonisation of the energy sector. To the same extent, energy decarbonisation is only possible with transforming fossil fuel mining and solving mining related environmental challenges. For example, the Kazakhstan and Uzbekistan governments support the electrification of railway transport. However, in the long run, the electrification of railway transport will not make any sense if the electricity is generated using fossil fuels. All CA governments should do internal reviews to identify existing conflicts in decarbonisation initiatives and existing legislative frameworks. Transport decarbonisation actions aiming to increase the number of electric vehicles should include environmental measures for arranging proper disposal or recycling or electric batteries. It is essential to have consistent policies by creating workable mechanisms for coordinated efforts and achieving synergies across sectors.

CA government should evolve and transform fiscal and budgetary systems to open better windows of opportunity for increasing funding of infrastructure projects and attracting external finance in the decarbonisation of transport. CA governments should recognise the critical role that a well-functioning transport network plays in fostering economic growth and regional connectivity. It is crucial to reassess national budgets to ensure that a proportionate amount of funding is dedicated to the improvement and maintenance of not only national, but also regional and local roads. There is a need to establish better financing mechanisms to support transport infrastructure development and the successful running of decarbonisation initiatives in the transport sector. CA governments should diversify funding sources for transport decarbonisation projects by setting up dedicated funds, exploring public-private partnerships (PPPs), attracting private sector investments, seeking international cooperation, and exploring innovative financing models for sustainable transportation projects. However, to make any financial initiatives useful, increasing the effectiveness and efficiency of managing available public funds is vital. CA public servants should be prepared and incentivised to apply good practices in public expenditure management, such as transparency and public accountability. Establishment of the good public finance management practice could help CA governments to strengthen partnerships with development banks and international financial institutions to secure financial and technical assistance tailored to decarbonisation needs or negotiate favourable loan terms and conditions. If CA countries have effective fiscal and budgetary systems with accountable and transparent financial flows, international actors will be more attracted to engage in strategic dialogues.

CA governments should support regional cooperation among universities and other knowledge institutions to develop human capacities, foster innovation, and promote interdisciplinary research required to decarbonise transport successfully. Building the negotiating capacity of CA governments to secure favourable terms in financial agreements with international organisations is the primary condition for attracting sustainable funding. Therefore, CA governments should partner with universities to train officials in negotiation skills and provide them with the expertise needed to engage effectively with international financial partners. The

existing knowledge and capacity gaps underscore the need for research and learning focusing on climate change and decarbonisation of transport by engaging the academic community, which could facilitate the development of informed climate adaptation strategies in the CA region. CA universities could help enhance policy planning, implementation, and monitoring by participating in policymaking and proposing targets and indicators based on scientific assessments aligned with international climate change commitments. It is crucial to invest in capacity building for better project management to have enough CA experts and civil servants to plan, execute, and monitor transport projects effectively. CA universities can help in building demanded capacities in transport, energy, and other related sectors by continuing the training of public and private actors to improve the implementation of planned decarbonisation actions. There is an urgent need to build the capacity in project appraisal and feasibility assessment to ensure that proposed projects are evaluated for their economic, social, and environmental impact, reducing the likelihood of investing in projects with limited long-term value.

The partnership of CA governments with the private sector could create a favourable ground for supporting decarbonisation actions and improving the quality of management of transport infrastructure. If CA governments want to decarbonise transport, there is a need to foster collaboration between the public and private sectors to drive innovation. Encouraging public-private partnerships can facilitate developing and deploying new technologies, sustainable practices, and business models aligned with decarbonisation goals. CA countries can learn from Indonesian Clean Air Asia in 2020, a five-year eco-driving program that involved collaboration with private sector companies and other stakeholders, aiming to mitigate freight emissions. CA country's decarbonisation actions can still be enhanced by better incorporating innovative technologies and engaging companies to integrate climate-resilient measures into transport decarbonisation projects to enhance their sustainability and adaptability to changing climate conditions. The introduction of technology-driven solutions for real-time monitoring and management of highways via sensors, cameras, and other advanced technologies can help to implement real-time monitoring of the road infrastructure quality by detecting and signalling changes in weather conditions, structural deformations, or changes in traffic flow. The integration of dynamic traffic management systems allows for proactive maintenance and timely adaptation to changing conditions in real-time by optimising traffic flow, reducing congestion, and enhancing the overall efficiency of the transport infrastructure.

Better co-operation among key implementing actors operating at regional, national, and sub-national levels could improve the quality of planned and built infrastructure, extending the decarbonisation benefits to all regions of the CA countries and increasing public engagement and awareness. CA governments should establish better dialogues with their sub-national governments to develop transport infrastructure beyond main transit roads by addressing domestic connectivity, urban mobility, and regional integration, fostering a more stable and sustainable investment environment. CA governments should recognize the broader socio-economic benefits of a well-connected regional and domestic transport network and start prioritising such projects in their decarbonisation and investment planning. Better cooperation between national and local levels can improve the collection and availability of data on regional and urban transport that can be used to conduct regular and comprehensive assessments of transport infrastructure needs to identify gaps and opportunities for investment. The CA government should strengthen the capacities of local-level actors responsible for managing and maintaining regional transport infrastructure by delegating decision-making authority and allocating enough budget resources. CA local government could be better supplied with resources for implementing a routine system

of road inspections to identify and address potential safety hazards promptly, prevent deterioration and ensure that highways are safe and reliable for trade and transportation.

CA local governments have tighter links with the local businesses and communities and could be better actors for the rising public awareness and stakeholder engagement. The CA national government should encourage local governments to initiate public consultation processes, such as gathering input from industry, academia, civil society, and local communities on how to improve the quality of transport project implementation. It is crucial to strengthen local governments' planning, land-use, and transport management capacities to enhance rural and urban mobility and prevent traffic congestion. Local governments with increased managerial capacities will be able to adopt an integrated and sustainable transport planning approach, considering both urban and regional needs. The local level stakeholder engagement in the decision-making process ensures transparency in allocating funds for transport decarbonisation projects, builds trust and can help garner public support for decarbonisation actions. Local governments can partner with local education institutions and media actors for increasing population knowledge about national decarbonisation plans and how they will contribute to improving their living environment and decreasing negative impact of climate change. Local level actor can be incentivised to engage local communities through public awareness programs on road safety and the importance of well-maintained highways. Community involvement can contribute to safer road usage and foster a sense of responsibility among users for preserving highway infrastructure.

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