Visiting Fellow Program

Decarbonizing Road Transport: CAREC Countries' Transition to Electric Mobility

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Khalil Raza

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by Mr. Khalil Raza

Programs Manager, Energy and Climate at the Economic Cooperation Organization Science Foundation (ECOSF)

Project Supervisor: Dr. Hans Holzhacker

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Scholars were encouraged to conduct research on CAREC integration topics and comparative analyses between (sub) regions to obtain insights to promote and deepen regional integration among CAREC member countries, as anticipated in the CAREC 2030 strategy and stated operational priorities.

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Central Asia Regional Economic Cooperation (CAREC) Institute
21st Floor, Commercial Building Block 8, Vanke Metropolitan,
No. 66 Longteng Road, Shuimogou District, Urumqi, Xinjiang, the PRC, 830028

f: +86-991-8891151
LinkedIn: carec-institute
km@carecinstitute.org
www.carecinstitute.org

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Abstract

The road transport sector, which generates approximately 21% of the global transport emissions, is a significant contributor to greenhouse gas (GHG) emissions. In contrast, the Central Asia Regional Economic Cooperation (CAREC) region contributes approximately 14% of the global transport emissions. Electric vehicles (EVs) offer a promising pathway for accelerating the shift away from internal combustion engines. EVs are one of the most accessible and feasible solutions—the low-hanging fruit—that can be leveraged to effectively decarbonize road transport. The transition to EVs offers an effective pathway for decarbonizing CAREC's transport sector. Therefore, CAREC countries have incorporated transport-specific targets in their nationally determined contributions (NDCs), with a focus on promoting EVs to reduce transport sector emissions. However, levels of ambition and reliance on international support vary significantly across regions. In the CAREC region, the People's Republic of China (PRC) leads with ambitious targets, while others have conditional targets. Consequently, the transition would depend on external financial and technological support. The PRC is the largest EV market in the region and globally and dominates in terms of electric mobility adoption. EV adoption in other CAREC countries is gaining substantial momentum; however, they face challenges in scaling up, primarily because of high purchase costs and limited charging infrastructure. This report examines the potential of CAREC countries in transitioning to electric mobility while analyzing the challenges and required policy interventions. The report identifies four primary drivers of EV adoption in the region: policy support, declining battery costs, improved access to charging infrastructure, and localizing EV component supply chains. Most CAREC countries have introduced supportive policies; however, the strengths of the incentives and interventions vary. For instance, while the PRC offers comprehensive purchase subsidies, tax breaks, and import duty waivers, other countries rely more on relaxed import duties, policies, and limited tax exemptions. Nearly all CAREC countries import EVs, primarily from the PRC, reflecting the PRC's position as a global EV supplier. The report analyzes each CAREC country's transport emission profiles, current automotive markets, and policy incentives and frameworks, and provides tailored

recommendations. Pakistan, Uzbekistan, and Kazakhstan, with their established automotive production capacities, may become regional EV production and export hubs. Although Pakistan has a large automotive market, it lags behind in terms of EV adoption. It may prioritize affordable motorbikes and compact EVs by establishing robust partnerships with Chinese manufacturers to develop its local EV supply chain. To promote electric mobility in other smaller markets with limited local manufacturing, import duty exemptions and targeted subsidies are essential. The report also underscores the need for CAREC countries to adopt a holistic "avoid-shift-improve" approach, where the focus is on reducing mobility demand, shifting to cleaner transport modes, and improving vehicle technology. A basic charging infrastructure network is recommended as a priority investment for supporting early adopters and encouraging private investment. Additionally, the report recommends that countries with high carbon-intensive grids, such as Kazakhstan, Uzbekistan, and Mongolia, diversify their power production and decarbonize their grids to fully realize the climate benefits of EVs. For countries with cleaner electricity grids, such as Tajikistan and the Kyrgyz Republic, leveraging carbon credits could further incentivize EV adoption. While the path to electric mobility remains challenging for many CAREC countries, a well-coordinated strategy across the region, leveraging the PRC’s expertise and leadership in EV technology, can accelerate the transition. Comprehensive policy support, investments in infrastructure, and regional collaboration are critical for achieving CAREC’s decarbonization objectives and building a sustainable, low-carbon future for the transport sector. The study begins by examining global electric mobility trends, identifying the key drivers of growth, and highlighting leading countries. Then, it delves into the current state of transport emissions and explores how electric mobility can contribute to the decarbonization of road transport. The automotive landscape in CAREC countries is comprehensively analyzed, including the current levels of EV adoption and existing policy frameworks. This study also discusses the intra-regional trade of EVs and presents a dedicated chapter on China's emergence as a global leader in this sector. Subsequent sections assess the climate benefits of transitioning to EVs within CAREC, noting that some countries, such as Tajikistan, may experience significant advantages, while others,

such as Turkmenistan, may see limited benefits owing to the high carbon intensity of their electricity grid. The economic benefits to consumers, impact on oil demand, requirements for charging infrastructure, and effects on the electricity grid are thoroughly examined. Finally, country-specific policy recommendations to facilitate the transition to electric mobility in the CAREC region are provided.

Decarbonizing Road Transport: CAREC Countries' Transition to Electric Mobility

Climate change is a pressing global challenge. The road transport sector is a major contributor to global warming, comprising more than a third of global greenhouse gas (GHG) emissions amongst the end-use sectors (International Energy Agency, 2025). The average growth rate of transportation emissions was 1.7% from 1990 to 2022, more rapid than that of other end-use sectors, with the exception of industry (International Energy Agency, 2025). Fossil-fuel combustion during transport is the primary source of these emissions. Electric vehicles (EVs) offer a promising solution for decarbonizing the transport sector because they are 4-6 times more energy-efficient than traditional internal combustion engine vehicles (ICEVs) (Clean Charge Network, 2020). As global and regional efforts intensify to combat climate change, decarbonizing road transport has become a top priority. Hence, the transition to electric mobility (e-mobility) offers a viable pathway to reduce emissions, improve air quality, and drive sustainable development.

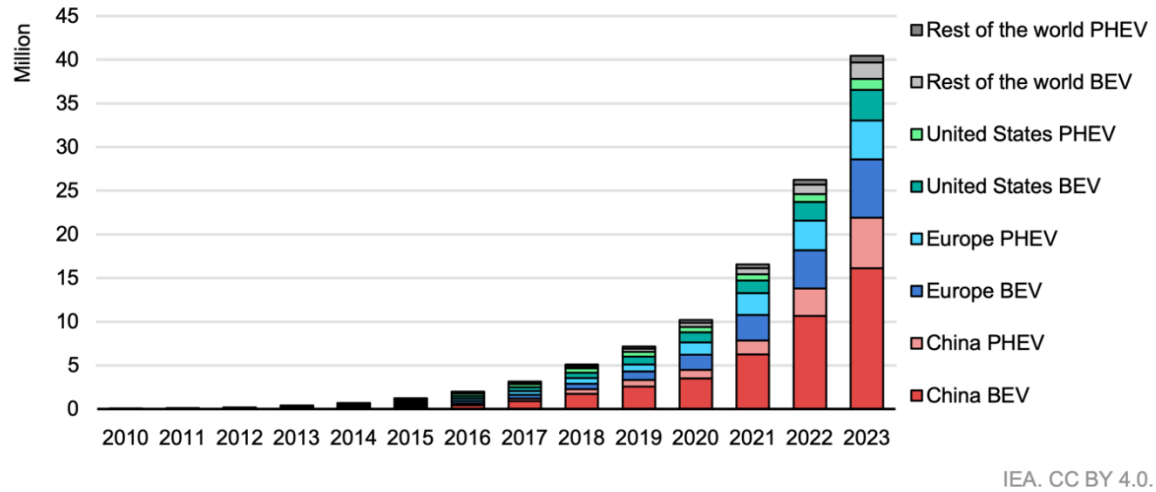
Similarly, the transport sector is one of the largest sources of GHG emissions in the Central Asia Regional Economic Cooperation (CAREC) region. Thus, it is imperative to develop and implement sustainable alternatives to fossil fuels for road transportation to reduce emissions and mitigate negative impacts on environment and public health. Globally, EVs are gaining momentum because of their high energy efficiency, low running and operating costs, and low tailpipe emissions. Owing to their numerous advantages, the global EV fleet has grown rapidly, primarily driven by government-backed policy support, technological advancements, and decline in lithium-ion battery (LIB) costs.

Electric cars are making significant progress towards becoming mass-market products in several countries, mainly in the People's Republic of China (PRC), European Union (EU), and US. In recent years, EV sales has grown significantly, with an improved range and wider model availability. According to the Global EV Outlook 2024, the global sales of electric cars totaled 14 million, accounting for 18% of all car sales, compared to 14% in 2022 (International Energy Agency (IEA), 2024). Moreover, electric car sales in 2023 were 3.5 million higher (35% year-on-year increase) than

those in 2022. Chinese carmakers have produced more than half of all electric cars sold worldwide by 2023, despite accounting for just 10% of global sales of ICEVs (International Energy Agency, 2024) Chart 1 presents the worldwide EV sales, with the PRC dominating the global EV market.

Chart 1

Global Electric Car Strock Trends (2010-2023)



Notes: BEV = battery electric vehicle; PHEV = plug-in hybrid vehicle. Includes passenger cars only.
Sources: IEA analysis based on country submissions and data from ACEA, EAFO, EV Volumes and Marklines.

Apart from the PRC—the leading market for EVs globally—other CAREC countries have limited adoption of EVs, primarily due to high purchase cost and scarce charging infrastructure. To overcome these barriers and promote the widespread adoption of EVs in CAREC economies, efforts must be made to improve affordability and expand charging infrastructure. Recognizing the numerous economic, environmental, and social advantages of e-mobility, CAREC countries have formulated national policies with varying degrees of incentives and policy support. To further encourage the use of EVs in CAREC economies, the lack of technical and policy-making capabilities should be addressed and incentive programs should be developed for both consumers and manufacturers.

This report explores the strategies, opportunities, and challenges associated with the transition to e-mobility in CAREC countries. It also examines the current state of the e-mobility industry, climate profiles, market demand across different vehicle segments, infrastructure, and

technological readiness to provide insights into how CAREC countries could accelerate their shift towards a sustainable and low-carbon road transport sector.

While several studies have examined electric mobility within CAREC countries, there has been limited analysis of the region. Existing research lacks a regional approach that considers shared challenges, cross-border trade dynamics, and policy coordination opportunities. This study addresses that gap by providing the region-wide assessment of electric mobility. It delivers country-specific recommendations based on transport emissions, energy profiles, and automotive capacities. The report offers practical, actionable insights for policymakers and stakeholders working toward a coordinated transition to low-carbon transport in the CAREC region.

Growth Momentum in Electric Vehicles

Globally, the growth of EVs is mainly driven by four factors: declining purchase cost, improved driving range, diversity of models, and expanding charging infrastructure. Price comparability is a significant barrier because EVs cost more than similar ICEVs (Weldon et al., 2018). Many countries have addressed the issue of higher cost differentials by offering generous subsidies and incentives. As EV prices continue to decline, the global market may see an increasing number of EVs on roads.

The steep decline in the cost of LIBs is a key driver of the increasing adoption. Battery prices have dropped significantly in the past decade from over US$ 1,000 per kWh to less than US$ 140 per kWh by 2024 (Bloomberg New Energy Finance, 2023). As battery costs continue to fall, the price gap between EVs and traditional ICEVs would reduce, making EVs more accessible to consumers, particularly in the price-sensitive markets in the CAREC region.

Climate Actions and Decarbonization Pathway for the Road Transport Sector in the CAREC region

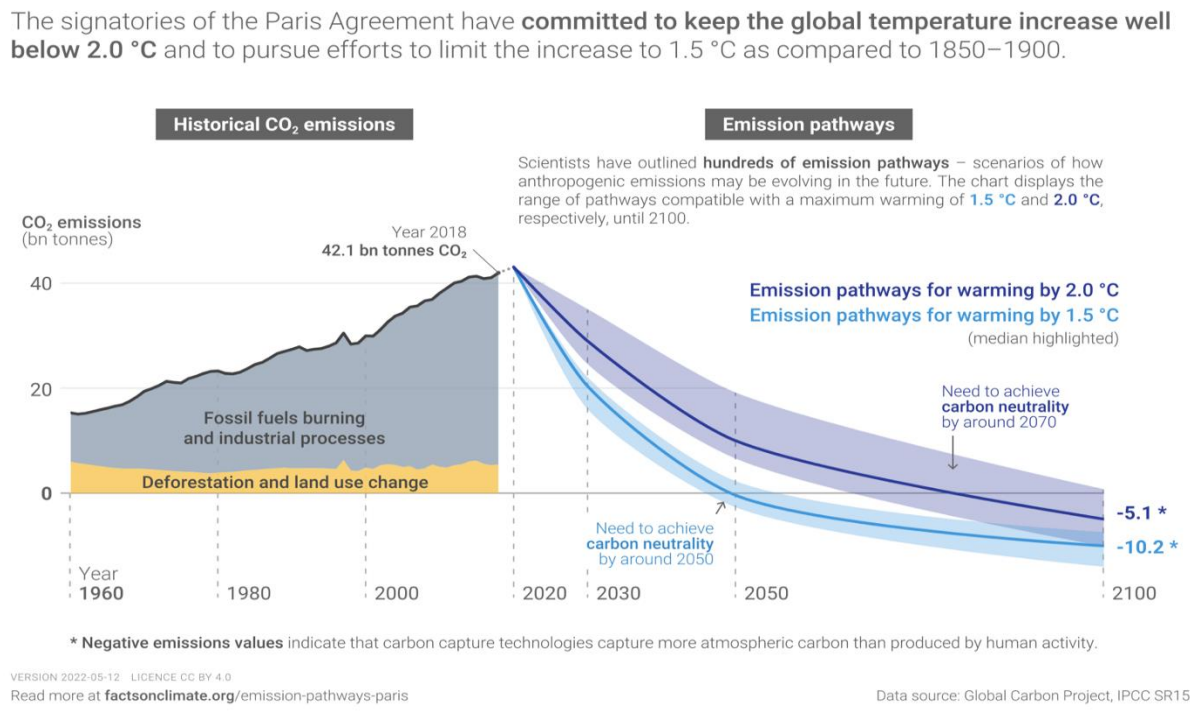
The transport sector is one of the fastest-growing contributors to GHG emissions. To meet the Paris Agreement's goal of limiting global temperature rise to below 1.5 °C, immediate actions to decarbonize the road transport sector is critical Chart 2 highlights the global historical CO2 emissions and pathways for achieving carbon neutrality. The accelerated EV adoption is a practical solution for

achieving this goal. However, it requires robust policy frameworks and financial support, particularly in developing countries. As observed in many countries, with appropriate policies in place, both developing and developed economies can drive high growth in the EV sector.

Currently, the transport sector is responsible for over 21% of global CO_2 emissions. Road vehicles represent the vast majority (74.5%), accounting for 15% of the total CO_2 emissions (Chart 3) (Ritchie, 2020). With rising incomes, population, and vehicle ownership, the global demand for mobility is expected to increase significantly, which could further increase road transport emissions.

Chart 2

Historical CO2 Emissions and Pathways

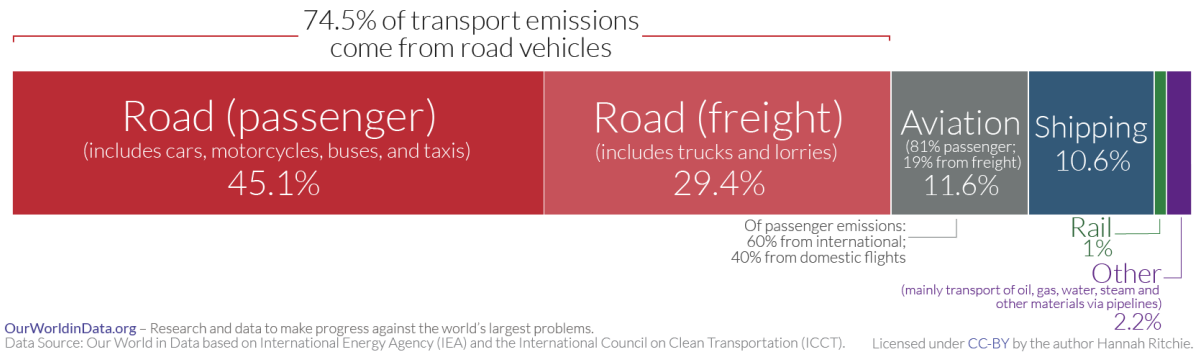


Source: Facts on climate (https://factsonclimate.org/).

Overall, the CAREC region contributes 30% of global emissions, largely driven by the PRC. Hence, the region faces an urgent need to transition to e-mobility to reduce transport emissions, in line with international climate commitments. With the PRC leading global EV adoption, the region has a unique opportunity to accelerate decarbonization by leveraging Chinese expertise and experience.

Chart 3

Global CO2 Emissions From Transport



Source: OurWorldinData (https://ourworldindata.org/).

The Transport Emissions Landscape in CAREC Countries

The CAREC region contributes approximately 14% to the global transport emissions. Notably, over 88% of the emission is attributed to the PRC, which produces 996.35 MtCO2e transport emissions—approximately 17 times greater than the combined total emissions of all other CAREC countries. However, it has the lowest emission intensity in terms of emissions per GDP—837.14 tCO2e/million $GDP—which reflects the economy's higher energy efficiency. The PRC has lower transport emissions per capita (0.71 tCO2e/person) in the region, likely due to the greater industrial emissions of its total footprint. Table 1 presents the emission profiles of CAREC countries, indicating climate intensities per capita, per GDP, and transport emissions share of their total emissions. Chart 4 presents road transport emissions in CAREC countries.

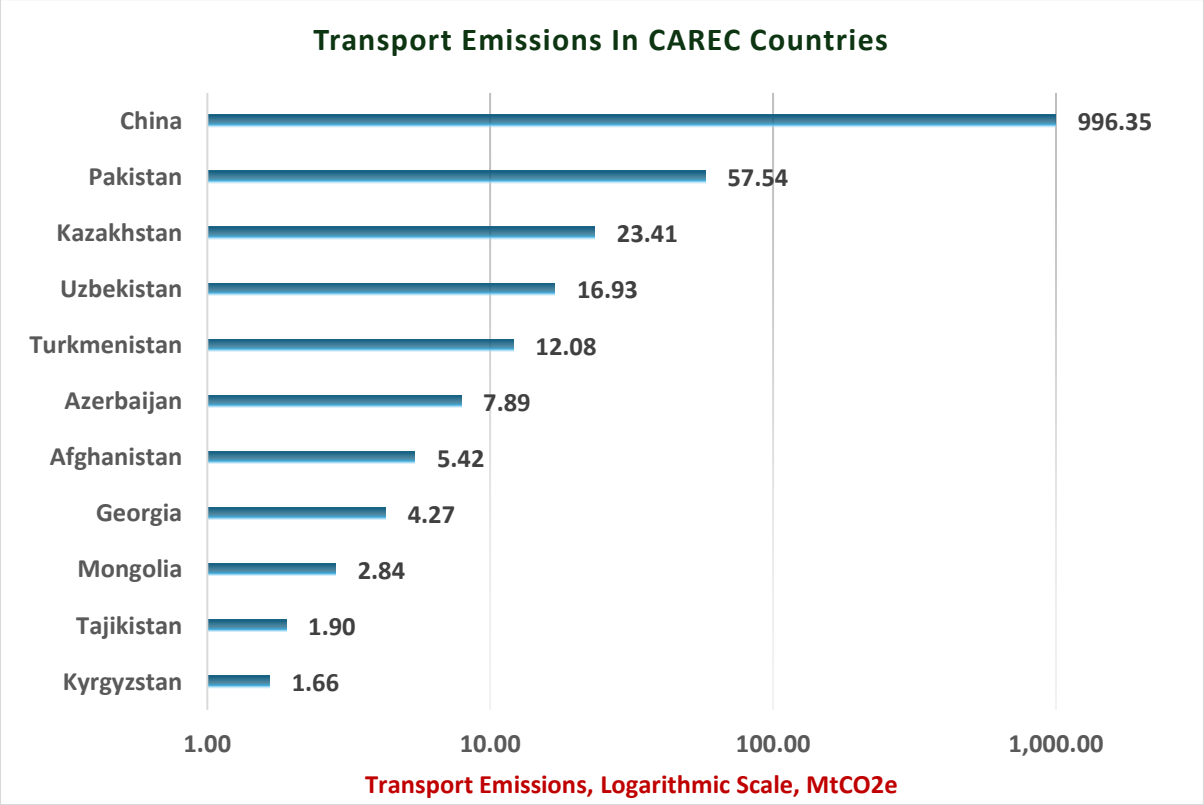
Pakistan ranks second in absolute transport emissions (57.54 MtCO2e). Although this figure is smaller than that of the PRC, it underlines the environmental impact of Pakistan's transport sector in the region. However, in terms of transport emissions per capita, Pakistan is one of the lowest contributors with only 0.24 tCO2e/person. In absolute terms, Pakistan's transport emissions highlight the need for targeted interventions, particularly in promoting EVs and improving efficient public transportation infrastructure to achieve its climate goals and economic sustainability.

Similarly, Central Asian economies, such as Kazakhstan and Turkmenistan, have substantial transport emissions driven by their large land areas and necessity for extensive road transport.

Turkmenistan (1.70 tCO2e/person), and Kazakhstan (1.19 tCO2e/person) have the highest transport emissions per capita, suggesting their high overall emissions, reliance on fossil fuel-powered transport, and large geography. Electricity generation in Turkmenistan relies entirely on fossil fuels, predominantly natural gas. Consequently, the energy sector is the largest contributor to national GHG emissions (International Energy Agency, 2022). This reflects the country's energy-intensive economy and the need to decarbonize electricity generation and energy supply. Georgia (1.15 tCO2e/person) closely follows Turkmenistan and Kazakhstan, despite having a much lower total emission profile (17.69 MtCO2e), which suggests that a significant portion of its emissions originate from road transport.

Chart 4

Road Transport Emissions in CAREC Countries



Source: ClimateWatch, data compiled by Author

In Central Asian countries, Tajikistan (0.24 tCO2e/person), and Kyrgyzstan (0.19 tCO2e/person) exhibit lower transport emissions per capita, likely due to lower private vehicle ownership and greater dependence on public transport. Azerbaijan (0.78 tCO2e/person) and Mongolia (0.84 tCO2e/person) also have moderate transport emissions per capita. Although, Mongolia has a lower contribution to GHG emissions in absolute terms, it has the highest emissions intensity per GDP (5,736.89 tCO2e per million $GDP) (Asian Development Bank, 2022). This high emission intensity underlines the need for targeted efforts to decouple economic growth from carbon emissions, potentially through increased energy efficiency in various economic sectors and adoption of cleaner technologies. Afghanistan (0.14 tCO2e/person) has the lowest transport emissions per capita, which could be attributed to its economic constraints and lower motorization rates.

A holistic approach should be adopted when designing policies to decarbonize road transport. EVs can be part of the solution, but a broader "avoid-shift-improve" strategy is vital for reducing the overall mobility demand. Planners must design cities that naturally minimize the need for frequent travel to encourage more sustainable mobility patterns. Urban planning that promotes walkability and cycling infrastructure can reduce the dependence on motorized transport, enabling more livable and environmentally friendly cities.

Encouraging the use of public transport is another crucial element for increasing transport efficiency. In addition to these measures, advancing zero-emission vehicle (ZEV) technology, including EVs and hydrogen/fuel cell-powered vehicles, is essential for achieving long-term decarbonization goals. It is important to consider that for EVs to deliver meaningful climate benefits, electricity generation must transition to cleaner energy sources, including renewables. Additionally, production facilities for EVs and batteries must adopt sustainable practices, and batteries should be efficiently recycled to minimize environmental impacts. Thus, the **avoid-shift-improve** approach involves:

a. Avoiding unnecessary transport demand by promoting cycling and walking.

b. Shifting to cleaner and more efficient transport modes, such as public transit or non-motorized transport.

c. Improving vehicle technologies by transitioning to EVs and other low carbon alternatives.

Table 1

Emission Profiles by Total, per Capita, and per GDP and Share of Transport Emissions of CAREC Countries, 2022

Source: Asian Transport Outlook Database, data compiled by the Author

Country*	Total Emissions (MTCO2e)	Emissions/capita (TCO2e/person)	Transport Emission/capita (TCO2e)	Emissions/GDP (TCO2e/million US$ GDP)	Population (million)	GDP/CAPITA (USD)	Transport Emissions (MTCO2e)	Transport Emissions Share (%)
AFG	31.27	0.8	0.14	1554.66	39.84	517	5	17%
AZB	53.45	5.3	0.78	1251.89	10.15	4,230	8	15%
PRC	12,296	8.71	0.71	837.14	1412.36	10,409	996	8%
GEO	17.69	4.75	1.15	1116.44	3.71	4,256	4	24%
KAZ	291.82	15.56	1.19	1705.74	19	9,122	23	8%
KYR	12.83	1.95	0.24	1648.49	6.69	1,183	2	13%
MON	76.38	23.3	0.84	5736.89	3.33	4,061	3	4%
PAK	443.6	2.01	0.24	1477.17	225.2	1,360	58	13%
TAJ	17.56	1.84	0.19	2159.29	9.75	853	2	11%
TUR	194.09	32.18	1.70	-	6.12	-	12	6%
UZB	184.15	5.38	0.49	3074.66	34.92	1,750	17	9%

Notes: AFG, Afghanistan; AZB, Azerbaijan; PRC, People's Republic of China; GEO, Georgia; KAZ, Kazakhstan; KYR, Kyrgyz Republic; MON, Mongolia; PAK, Pakistan; TAJ, Tajikistan; TUR, Turkmenistan; UZB, Uzbekistan.

Nationally Determined Contributions (NDCs) in the Context of Decarbonizing the Road Transport Sector in CAREC Countries

In response to the Paris Agreement, CAREC countries have made climate commitments through their respective Nationally Determined Contributions (NDCs) to address the need to transition towards low-carbon transport solutions. NDCs are climate action plans and commitments

of countries under the Paris Agreement to reduce national GHG emissions and adapt to the impacts of climate change. NDCs play an important role in achieving long-term climate goals, which include limiting global temperature rise to below 2 °C above pre-industrial levels with an end goal to limit the increase to 1.5 °C.

The NDCs of CAREC countries provide a framework for understanding their commitment to reducing GHG emissions. Given that the road transport sector is a significant contributor to emissions, these NDCs are relevant to the decarbonizing efforts in this sector. Table 2 presents the GHG reduction targets of CAREC countries as per recent NDCs.

Most of the NDCs include transport-related emission-reduction targets. The NDCs reflect varying levels of ambition, capabilities, and reliance on international support across the CAREC region. For instance, with its significant industrial and economic capacity, the PRC has set an ambitious unconditional target to peak its CO2 emissions before 2030 and achieve carbon neutrality by 2060. Among CAREC countries, the PRC, Uzbekistan, and Turkmenistan have unconditional targets in the NDCs, while others, including Afghanistan, Azerbaijan, Kazakhstan, Pakistan, and Mongolia, have conditional targets that depend on international support. Therefore, successful implementation of interventions underlined in the NDCs rely on external resources, including financial aid, technology transfer, and capacity building, to achieve meaningful reductions in GHG emissions in the road transport sector.

Current State of the Automotive Industry in the CAREC region

The CAREC region has diverse economies and levels of development, presenting a unique landscape in terms of automotive market size, annual sales, and local production capabilities. The PRC dominates the automotive landscape in this region across all metrics, including annual sales and local automotive production.

Other than the PRC, Pakistan, Uzbekistan, and Kazakhstan are the major automotive markets that collectively account for most vehicle sales. Pakistan is one of the largest automotive markets, with 227,392 annual vehicle sales, closely followed by Uzbekistan, with 205,145, and Kazakhstan,

with 101,527 annual vehicle sales. Uzbekistan and Kazakhstan are emerging as major automotive players in Central Asia. Their production capacities have grown substantially over the past few years. Thus, they can serve as regional trade hubs and offer opportunities for exports to other Central Asian States.

Table 2

Nationally Determined Commitments By CAREC Countries, Highlighting Greenhouse Gas Reduction Targets and Conditionalities

National Determined Contribution to Paris Agreement by CAREC Countries	
Afghanistan	13.6% reduction in GHG emissions by 2030 compared to a business as usual (BAU) scenario, conditional on external support.
Azerbaijan	40% reduction in emissions by 2050 from 1990 levels, conditional on international support.
People's Republic of China	Peak CO2 emissions before 2030 and achieve carbon neutrality before 2060; lower CO2 emissions per unit of GDP by over 65% from the 2005 level (unconditional).
Georgia	35% (unconditional) and 50%-57% (conditional) reduction by 2030 from the 1990 level of its domestic total greenhouse gas emission.
Kazakhstan	Reduce greenhouse gas emissions by 15% (unconditional) and 25% (conditional) compared to 1990.
Kyrgyz Republic	Reducing its emissions by 16.63% by 2025 and by 15.97% by 2030 compared to BAU (unconditional), and by 36.61% by 2025 and 43.62% by 2030 compared to BAU (conditional).
Mongolia	Unconditional: 22.7 percent reduction from BAU by 2030, excluding Land Use, Land-use Change, and Forestry (LULUCF). Conditional: 27.2 percent reduction from BAU by 2030, excluding LULUCF.
Pakistan	Conditional and voluntary contributions of overall 50% reduction of projected emissions by 2030, with a 15% drop below BAU from the country's own resources, and an additional 35% drop below BAU subject to international financial support.
Tajikistan	Not exceeding 60-70% (unconditional) and 50-60% (conditional) of 1990 emissions levels by 2030.
Turkmenistan	20% reduction of greenhouse gas emissions in 2030 compared to the BAU scenario relative to 2010 emission levels.
Uzbekistan	Reduction of specific emissions per unit of GDP by 35% by 2030 compared to 2010 levels.

Source: ClimateWatch, data compiled by Author. **LULUCF** stands for Land Use, Land-use Change, and Forestry, and it's a key sector in global climate change efforts. It encompasses emissions and removals of greenhouse gases (GHGs) resulting from land use activities like agriculture, forestry, wetlands, and settlements, as well as changes in land use.

Other CAREC countries, including Azerbaijan, Turkmenistan, Mongolia, Georgia, Tajikistan, and the Kyrgyz Republic, have smaller automotive markets, with annual sales below 10,000 units, which do not offer the economies of scale for profitable vehicle manufacturing. Therefore, these CAREC countries are likely to continue to rely on EV imports from the PRC and major automotive manufacturers in Europe. They may focus on creating favorable import policies and incentivizing the adoption of electric and hybrid vehicles to meet their decarbonization goals. This trend is evident in many non-producing automotive markets within the CAREC, where substantial incentives have been implemented to promote EV adoption.

Table 3

Vehicle Population, Annual Vehicles Sold, Local Vehicle Production, and Annual EV Sales in 2022

CAREC economy	Total Registered Vehicles	Annual Vehicle Sales	Local Production of Vehicles	Annual EV Sales	Ev Sales as a Percentage of Total Vehicle Sales
Afghanistan	2,011,692	-	-	-	
Azerbaijan	1,645,253	22,500	4,233	2592	12%
People's Republic Of China	310,331,900	26,863,745	27,020,615	8,100,000	35%
Georgia	1,563,200	6,300	-	2,725	43%
Kazakhstan	4,449,332	101,527	112,540	4,907	5%
Kyrgyz Republic	1,387,551	60,248	-	2,445	4%
Mongolia	1,234,701	3,800	-	338	9%
Pakistan	30,757,539	105,065	235,454	900	1%
Tajikistan	666,074	2,450	-	1300	53%
Turkmenistan	5,225	5,795	-	-	-
Uzbekistan	4,020,744	205,145	333,569	10,000	5%

Source: Author's analysis based on the Asian Transport Outlook, IEA, and multiple national and media reports from CAREC countries.

In terms of local production, Uzbekistan ranks next to the PRC—the leader in the CAREC region—with an annual production capacity of 333,569 vehicles, followed by Pakistan with 235,454

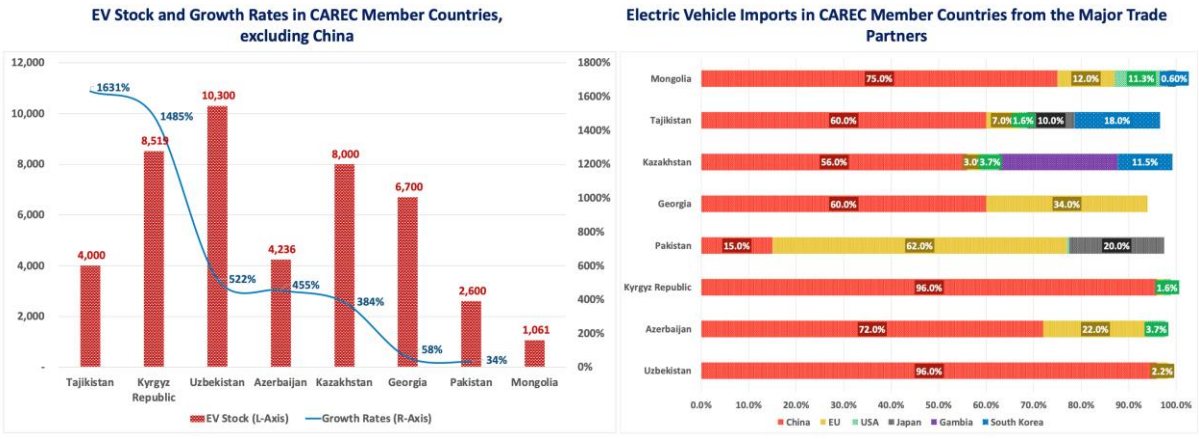
units and Kazakhstan with 112,540 units Table 3 presents the automotive markets in CAREC in terms of vehicle population, annual sales, production and EV sales in 2022. With their robust vehicle production capabilities, these three countries could be well positioned to be the key players in EV production. Transitioning from traditional ICEVs to EVs for local production would be relatively straightforward for existing automakers, if they have sufficient demand for EVs. In this regard, favorable policies are crucial for building consumer confidence, which will ultimately drive the widespread adoption of EVs.

In terms of EV sales as a percentage of the total annual vehicle sales in the CAREC region, Tajikistan (53%) and Georgia (43%) have the highest EV adoption rates. This trend is largely driven by the high cost of petroleum in both countries, coupled with some of the lowest electricity tariffs in the region, making the switch to EVs economically advantageous for consumers. Azerbaijan and Mongolia also have decent adoption rates of 12% and 9%, respectively.

Kazakhstan and Uzbekistan (approximately 5%) demonstrate early adoption trends, with EVs gradually gaining popularity in absolute terms. However, Pakistan has the lowest EV adoption rate (1%), primarily owing to its high import duties and taxes coupled with the highest electricity tariffs in the region, which lowers the economic benefits of switching to EVs.

Chart 5

Current Adoption Levels: Electric Vehicles in the CAREC Region



Notes: Compiled by Author based on the data from TradeMap.

Chart 5 highlights the current EV adoption levels and EV imports from major global automotive markets. EVs are gaining momentum across the region and are largely fueled by exports from major Chinese suppliers. This rapid growth in EV adoption is likely driven by favorable policies such as import duty waivers, increased consumer awareness of lower operational costs, and newly established partnerships between Chinese manufacturers and local assemblers in the CAREC region.

Recently, Uzbekistan has partnered with BYD, with an annual EV production capacity of 50,000 units (CleanTechnica, 2024). Kazakhstan is also working with JAC, KIA, GEELY, and EXCEED to boost its EV production capacity. Pakistani automakers have partnered with major EV producers, including BYD, CHANGAN, Great Wall Motors, and MG Motors, and launched several new variants in 2024. Evidently, the PRC is leading the EV export in the CAREC economies, with the exception of Pakistan, which has distinct trade patterns with European and Japanese automakers, driven by historically established industry relationships.

In terms of the current EV stock, Uzbekistan has more than 10,300 EVs. The Kyrgyz Republic follows closely, with more than 8,519 EVs, likely driven by recent import duty exemptions for EVs (Center for Strategy and Cultural Diplomacy, 2024). Surprisingly, the Kyrgyz Republic has achieved a high EV adoption in recent years, despite its smaller automotive market, raising the possibility of re-exports to other countries. Kazakhstan has also built an impressive EV stock of 8,000 units, supported by ongoing electrification initiatives.

Although Pakistan is a major automotive market in the region, its EV adoption is slow, with only 2,600 EVs in stock. This is likely due to the high import tariffs, duties, and taxes in the automotive industry. Although it has provided some import concessions, they are limited to local production under completely knocked down (CKD) arrangements. Another distinguishing factor in Pakistan's market is its trade patterns. Unlike other CAREC countries, Pakistan imports EVs predominantly from the EU (62%) and Japan (20%).

When analyzing EV imports across CAREC countries, the PRC emerged as a major supplier. Nearly every country relies heavily on Chinese EVs to meet growing domestic demand. This

highlights the role of the PRC as a global leader in EV manufacturing and its dominant position as a key exporter in the region.

Electric Vehicle Policy Framework in the CAREC Region

To analyze the policy framework promoting EV adoption in the CAREC region, this study compared the major policy instruments (Chart 6). It examined the policy initiatives that have been the strongest support determinants and had the greatest impact on EV adoption in the region.

This analysis is based on five key metrics that represent the most significant factors: mandated national EV targets, purchase subsidies, import duty waivers, tax subsidies, and preferential loans for EVs. We ranked the effectiveness of these interventions into four categories: *highly effective* (strong green), *strong* (light green), *limited impact* (white), and *not being implemented* (light red).

Chart 6

Key Policy Incentives for Electric Vehicle Adoption in CAREC Countries

CAREC Economy	Mandated National Targets - % of sales of EV	Purchase Subsidies	Import Duties Waivers	Tax Subsidy (Purchase Tax, VAT, ST or Excise)	Preferential Loans for EVs
Afghanistan	Data Not Available				
Azerbaijan	ZEVs by 2035	No	Exempted	Excise and VAT - Exempted	No
PRC	45% of new vehicle sales by 2027 and 60% by 2030	Yes		Purchase Tax - Exempted	Yes
Georgia	EV sales 50% by 2030,	No	Exempted	Excise Tax - Exempted	Yes
Kazakhstan	No	No	Exempted	Transport Tax - Exempted	No
Kyrgyz Republic	No	No	Exempted	Annual Registration Tax - Exempted	Yes
Pakistan	4Ws - 30% by 2030 and 90% by 2050 - Buses and Trucks 30% by 2030 and 90% by 2050, Motorbikes 50% by 2030 and 90% by 2050	No	Exempted for CKD Units	General Sales Tax Exempted for CBU and CKD	No
Tajikistan	No	No	Exempted	VAT and Excise Duty Exempted for 10 Years	No
Turkmenistan	Data Not Available				
Uzbekistan	20% EV share of Fleet by 2035	No	Exempted	Excise Tax Exempted	Yes

Highly effective
Strong
Limited Impact
Not being implemented

- Consumer perspective: Economics, Convenience and Reliability
- The purchase cost remains the most significant barrier to EV adoption.
- Waiving import duties and providing purchase subsidies have been effective strategies in increasing EV sales and adoption rates.
- Non fiscal incentives – priority lanes, parking and road tolls

CKD = Completely Built Unit, CKD = Completely Knocked Down, ZEV – Zero Emission Vehicles, 6

Source: IEA EV Policy Data Explorer, CAREC Institute, Asian Transport

Source: Compiled by Author using EV Policy Database Explorer of International Energy Agency (IEA) and Asian Transport Outlook.

While e-mobility progressed in the CAREC region, the strength and breadth of policy incentives vary significantly between countries. The PRC leads, establishing a comprehensive range of incentives starting as early as 2009, with mandated national targets, purchase subsidies, import

duty waivers, and tax exemptions. This robust framework is the cornerstone of the PRC's rapid success as the world's largest and fastest growing EV market.

Notably, purchase cost remains one of the most significant barriers to EV adoption (Transport Environment, 2024). Globally, countries have implemented various policy options to reduce purchase costs to make EVs more competitive with traditional ICEVs. Purchase subsidies have proven to be among the most effective tools for reducing EV costs and driving consumer uptake (International Energy Agency, 2021). However, in the CAREC region, only the PRC offers purchase subsidies, which has played a significant role in accelerating its EV market since its initial phase.

The mandated national targets for EV adoption are important policy instruments that guide market growth. The PRC has established an aggressive target of 45% of new vehicle sales to be electric by 2027 and 60% by 2030 (International Energy Agency, 2024). Azerbaijan has also committed to an extremely ambitious target of achieving zero emission vehicles (ZEVs) by 2035, whereas Georgia and Uzbekistan have set ambitious targets of 50% EV sales by 2030 and a 20% EV share of the fleet by 2035, respectively. Pakistan has also adopted impressive EV adoption targets as part of its National Electric Vehicle Policy. By contrast, countries such as Kazakhstan, the Kyrgyz Republic, and Tajikistan are yet to announce national targets, but their current EV adoption levels indicate robust progress.

Worldwide, the exemption of duties on EVs has been the most effective instrument to reduce the upfront EV cost and accelerate EV adoption, especially in countries without local EV manufacturing (Fastmarkets, 2024). However, the EU and USA have imposed varying levels of duty to limit the entry of Chinese EVs into their domestic markets.

Apart from the PRC, all CAREC countries rely on EV imports to meet their domestic demand. Therefore, waiving import duties on EV is one of the most widely adopted incentives in the CAREC region. Almost all member countries have implemented import duty exemptions to lower EV costs. However, in Pakistan, which has a large automotive market, import duty exemptions apply only to local production (Board of Investment, 2020). Given the fact that the market is still nascent,

countries need to provide some level of import duty exemption to reduce costs and build the confidence of consumers around EV ownership. Once there is significant momentum and local production, the exemption can be lifted to provide space for local EV producers.

Tax subsidies are another important tool for reducing the overall cost of EV ownership. Almost all CAREC countries offer tax exemptions, including value-added tax (VAT), excise taxes, and other purchase-related taxes. These exemptions further lower the cost of owning and operating EVs, allowing EVs to be cost competitive with ICEVs. Thus, CAREC countries must ensure that their policies address the primary barriers to EV adoption—namely, high purchase costs—through fiscal and non-fiscal incentives, import duty exemptions, and other financial mechanisms.

Innovative Financial Mechanisms to Promote EV Adoption

Government policy incentives such as tax breaks, import duty exemptions or concessions, and preferential loans play a crucial role in supporting EV adoption. However, these measures alone are insufficient, particularly in the context of private sector investments in CAREC countries, many of which face significant financial constraints. To scale up EV adoption, there is a pressing need for innovative financial mechanisms to attract private sector investment. International green or climate financing, public-private partnerships (PPPs), carbon credits, and green bonds could offer promising solutions to overcome these barriers. Following are some innovative financing strategies that can be leveraged by CAREC countries to accelerate EV adoption.

International Development and Climate Financing

The private sector is hesitant to invest in e-mobility business models because of the higher capital requirements and perceived risks associated with public EV business models (Green Climate Fund, 2024). To overcome these barriers, the Green Climate Fund (GCF) has provided grants to developing countries, including India and Latin American countries, to develop EV infrastructure and scale up EV adoption (Green Climate Fund, 2024). For instance, the GCF financing project in India aims to deliver US$ 1.5 billion to the e-mobility sector. This blended finance structure is designed to

attract private-sector capital by leveraging the GCF's commitment to provide a risk-mitigating buffer for commercial investors (MacQuarie, 2024).

Green Bonds

Green bonds are debt instruments to fund environmentally friendly projects and represent a viable financing mechanism for EV infrastructure and adoption. Governments or private entities can issue these bonds to raise capital for initiatives such as EV charging stations, renewable energy integration, or EV fleet procurement.

For example, in the UK, NatWest issued its first EV green bond (the "EV Green Bond"), raising net proceeds of €750 million from institutional investors across the UK, Europe, and Asia (NatWest Group, 2024). This issuance marks the NatWest Group as the first UK bank to issue a green bond, in which proceeds are exclusively allocated to financing or refinancing EVs.

Public-Private Partnerships (PPP) for Expanding E-Mobility

PPPs provide a collaborative framework for governments and private entities to combine resources and expertise, enhancing the efficiency and effectiveness of public services. In e-mobility, PPPs can finance the charging infrastructure, incentivize EV adoption, and support local EV manufacturing. A notable example is Kenya's PPP to develop a nationwide electric bus network, where the government offers policy support and land allocation, whereas private firms invest in electric buses and charging infrastructure (LeadVent, 2024).

Carbon Credits for Scaling Up EV Charging Infrastructure

Carbon credits incentivize carbon-reducing activities, such as EV charging and adoption, by providing funding from private carbon markets to scale up low-carbon technologies. Carbon credits offer an innovative way to accelerate the transition to electric transportation using private sector funds instead of relying on public funds. For example, Green Bank in Connecticut, US, has leveraged carbon credit financing to deploy EV charging systems across the country. Green Bank acts as an aggregator and facilitates access to capital, which is supported by Verra's Verified Carbon Standard

(VCS) Program (E + Eleader, 2023). This initiative involves utilities, charging networks, and startups that use carbon credits to enhance EV charging services.

Driving Factors of EV Adoption in CAREC Countries

The EV adoption rate in CAREC countries is influenced by the extent of policy support and economic development. However, four key factors are likely to significantly affect EV adoption in the region: (a) policy support, (b) decline in global battery costs, (c) access to reliable charging infrastructure, and (d) localization of the supply chain of critical components.

Battery cost is the biggest constraint in achieving economic parity for EVs, hindering their large-scale market penetration. Battery cost decline is a crucial driver of EV adoption because it significantly affects the upfront cost and helps achieve price parity between EVs and ICEVs. In the case of the PRC, which dominates the global LIB production, battery cost does not have a major influence on EV adoption. However, it could be significant in other CAREC countries that rely largely on imported supply chains.

Globally, battery costs have declined by approximately 85% over the last decade, and further decreases are expected. According to global forecasts, EVs are likely to achieve price parity with conventional ICEVs by 2025. This aligns with projections from Bloomberg New Energy Finance (BNEF), which predicted that LIB prices would drop to approximately US$ 100/kWh by 2024 (S&P) Global Market Intelligence, 2025). This cost reduction is driven by advances in battery and power component technologies and growing economies of scale, which are expected to further lower EV prices.

The US$ 100/kWh price point is a tipping point, where consumers will no longer perceive EVs as more expensive options. This would accelerate adoption, with more consumers likely to switch to EVs owing to favorable economics.

Regional Trade: Electric Vehicle Exports from the PRC to CAREC Member Countries

The PRC's EV exports are reshaping the global automotive landscape, with significant trade flows to CAREC countries such as Kyrgyzstan, Uzbekistan, and Kazakhstan. Table 4 shows the PRC's

EV exports to CAREC member countries in 2023. As the world's largest EV manufacturer, the PRC's reach in the CAREC region is transforming the regional e-mobility landscape.

Kyrgyzstan, Uzbekistan, and Kazakhstan are emerging top EV importers in the region. The PRC's EV exports to CAREC countries reached US$ 2.77 billion. This is dominated by battery EVs (BEVs), with the largest share of over US$ 1.5 billion, plug-in hybrid EVs (PHEVs), US$ 1.15 billion, and hybrid EVs (HEVs), US$ 109 million.

Table 4

Electric Vehicle Exports from the PRC to CAREC Countries in 2023

CAREC country	Battery Electric Vehicles (US$ million)	Plugged-In Hybrid Electric Vehicles (US$ million)	Hybrid Electric Vehicles (US$ million)	Total (US$ million)
Azerbaijan	49.59	28.69	21.64	**99.91**
Georgia	21.49	1.33	0.21	**23.04**
Kazakhstan	329.16	128.27	5.26	**462.70**
Kyrgyzstan	429.37	650.74	23.95	**1,104.06**
Mongolia	8.48	1.68	0.48	**10.64**
Pakistan	6.03	0.04	42.27	**48.34**
Tajikistan	40.84	2.81	1.36	**45.01**
Turkmenistan	0.27			**0.27**
Uzbekistan	623.39	339.47	14.69	**977.55**
Total	**1,509**	**1,153**	**110**	**2,772**

Source: China Customs Authority, compiled by the Author.

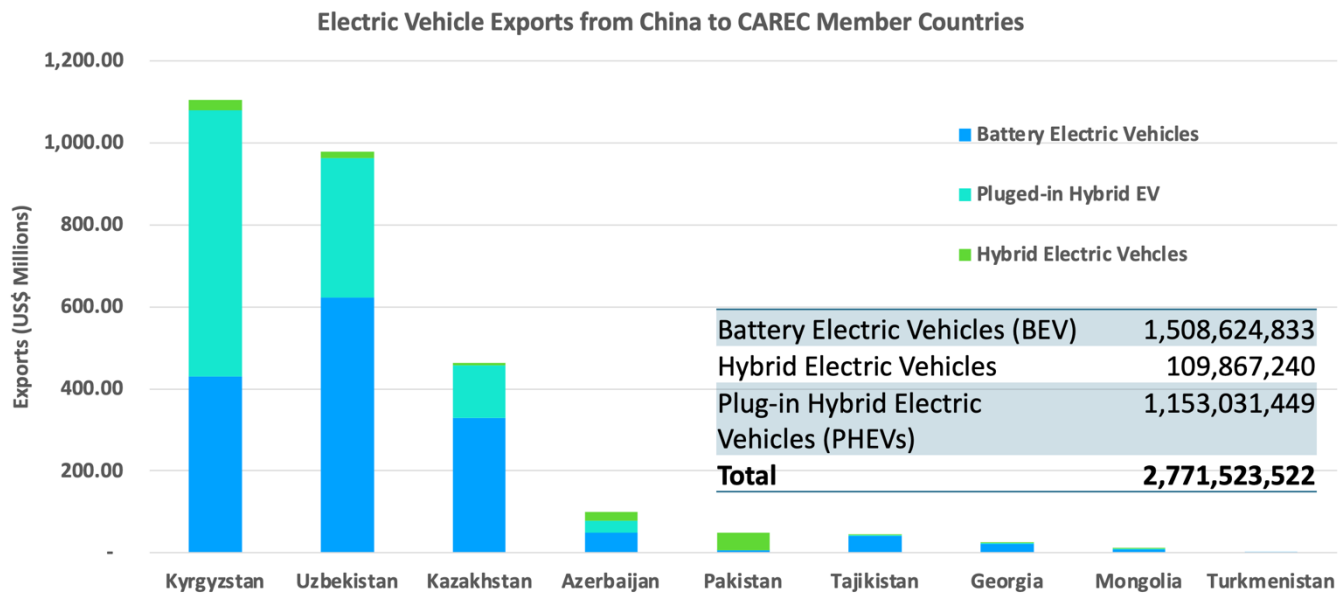
In the CAREC region, Kyrgyzstan imports an unexpectedly high volume (valued at US$ 1.1 billion) of EV from the PRC, outpacing the imports of even larger regional markets such as Pakistan, Uzbekistan, and Kazakhstan. This may be driven by its favorable import policies or by a robust push for clean mobility. It is highly likely that a substantial portion of these imported EVs are re-exported to Russia. This astonishing rise in imports highlights how even a smaller economy, such as the Kyrgyz

Republic, is adopting e-mobility at a rapid pace and indicates a potential shift in Central Asia's transport sector. Uzbekistan closely follows Kyrgyzstan in imports. Kazakhstan is another major player, importing over US$ 400 million worth of EVs Chart 7 exhibits the electric vehicles exports from PRC to CAREC Countries in 2023.

In contrast, other CAREC countries such as Azerbaijan, Pakistan, and Tajikistan demonstrate modest import volumes, valued less than US$ 100 million. As e-mobility demand grows globally and within the CAREC region, the PRC's role as the primary and largest supplier of affordable, high-quality EVs is likely to grow even further, supporting the transition towards clean transportation in the region.

Chart 7

Electric Vehicles Exports from the PRC to CAREC Countries in 2023



Source: TradeMap compiled by author.

Localization of the EV Supply Chain in CAREC Member Countries

Localization of the EV supply chain presents both opportunities and challenges for CAREC countries, depending on their existing automotive production capacity and market size. Countries such as Pakistan, Uzbekistan, Kazakhstan, and Azerbaijan, which have already established

automotive industries, are well positioned to localize EV manufacturing and assembly. They can leverage their existing production facilities, supply chain networks, and skilled labor to expand EV production.

However, localization is a significant challenge in smaller automotive markets, such as Tajikistan, the Kyrgyz Republic, Mongolia, and Georgia, with negligible annual vehicle production. Given the limited domestic demand, full-scale EV manufacturing may not be economically viable. Instead, these countries can focus on EV imports while developing localized assemblies for components such as batteries, charging infrastructure, and electric two-wheelers, which are more feasible given their market dynamics. Policies such as preferential tax incentives, reduced import duties, and joint ventures with foreign manufacturers can help facilitate gradual localization.

Battery Manufacturing Potential and Regional Collaboration in the region

Considering the capital-intensive nature of LIB production, a regional approach is more strategic. The PRC, the global leader in battery manufacturing, accounts for nearly 80% of global LIB production and offers a strong partnership opportunity for CAREC nations (The Atlantic Council, 2024). Countries with well-established industrial bases, such as Pakistan, Uzbekistan, Kazakhstan, and Azerbaijan, can develop local battery assembly plants in collaboration with Chinese battery giants such as CATL and BYD. Localized battery assembly, rather than full-scale cell manufacturing, would allow them to reduce their reliance on costly imports while still benefiting from technology transfer and job creation.

Critical Mineral Resources for Battery Production in the CAREC region

The availability of raw materials for battery production within a region provides another potential advantage of localization. Kazakhstan and Afghanistan have significant deposits of lithium, cobalt, and other critical minerals required for EV battery production. For example, Kazakhstan has over 50,000 metric tons of lithium reserves, and its government is actively exploring opportunities to develop its domestic mining and processing capacities (US Geological Survey, 2024). Afghanistan's untapped lithium reserves are estimated at up to US$ 1 trillion, although security and infrastructure

challenges pose obstacles to immediate exploitation (Brookings, 2022). Thus, strategic partnerships with the PRC, which already dominates global lithium refining, could help these CAREC countries develop their lithium processing and refining facilities, enabling the markets for regional trade and exports to international markets.

How China Became the Global Leader in Electric Mobility: Lessons for Other CAREC Economies

The PRC's rise as the global leader in e-mobility is a remarkable demonstration of its industrial vision, careful planning, strategic investments, and policy innovation. The PRC has long sought to become a global auto industry player. By the early 2000s, it had a sizable industry but was largely reliant on Western-designed cars manufactured through foreign joint ventures. The country leveraged EVs as an opportunity to leapfrog the internal combustion technology, which was dominated by Western and Japanese manufacturers, directly to ZEVs (International Council on Clean Transportation, 2021). Over the past two decades, the PRC has transformed from a nascent market to the world's largest EV manufacturer and market. Between 2009 and 2022, the PRC spent more than 200-billion-yuan (US$ 28 billion) on EV subsidies and tax breaks (Jamil, 2024). Its rapid progress and global leadership in EV industry can be categorized into three phases: early foundation (2000-2012), local EV market gain traction (2013-2017), and global expansion (2018-present).

Early Foundations (2000–2012)

The PRC's EV revolution began in 2001 with the 863 Program, which was led by the Ministry of Science and Technology (Ministry of Science and Technology of China, 2024). This program aimed to boost technological innovation across emerging industries, including semiconductors, biotechnology, space exploration, and EV development. It laid the foundation for technical innovation and advancement in EVs in the early 2000s.

In 2009, the PRC launched a national strategy to promote EV adoption through several strategic initiatives, including the "Ten Cities, Thousand Vehicles" program, which initially aimed to deploy 1,000 EVs in 10 cities and later expanded to over 25 cities (The World Bank, 2011).

Meanwhile, the Chinese government provided substantial subsidies and grants, with an allocation of over US$ 1.5 billion to establish large-scale pilot programs (International Council on Clean Transportation, 2023). With this initial funding, purchase subsidies were introduced and tax exemptions were provided for EVs. Simultaneously, the government supported and funded advancements in battery technology. This initial phase of the national e-mobility strategy focused on creating a sound foundation for a local EV market that relied heavily on government-backed subsidies, tax breaks, and policy support.

Local EV Market Traction (2013–2017)

During 2013-2017, the Chinese Government introduced aggressive policies, purchase subsidies, tax breaks, and environmental regulations, resulting in the rapid growth of the EV market. Owing to severe air pollution crises in major Chinese cities, the government acted swiftly to promote EVs. This resulted in policies that strongly favored EVs, particularly in heavily polluted urban centers such as Beijing. Moreover, city municipalities' investments targeted building a charging infrastructure.

A quota system was introduced, authorizing mandated EV purchases and introducing license plate restrictions on ICEVs, making EVs more attractive to consumers (DieseNet, 2025). Simultaneously, national and city-level governments set ambitious goals to electrify transportation, with clean air initiatives driving 84% of the market growth in 30 leading cities. This phase saw a clear shift in public perception, as the government's comprehensive clean-air strategies made EVs a necessity rather than a luxury.

Market Expansion (2018–Present): Competing Globally

As the national EV market matured, the PRC began phasing out subsidies and shifting towards a more competitive environment. This subsidy phase-out plan was a key moment in EV development, indicating that the local EV industry was ready to compete on quality and innovation rather than to rely primarily on government support (Dialogue Earth, 2023).

The PRC opened its market to foreign competition by relaxing its ownership restrictions. Consequently, local EV manufacturers focused on improving efficiency, reducing costs, and seeking competitive differentiation. Leading Chinese Brands, such as Nio, BYD, and Xpeng, emerged as global players, exporting EVs to international markets and competing globally (S&P Global Mobility, 2024). Lower battery prices and increased production capabilities sparked price wars, making EVs more affordable worldwide.

The PRC's journey to becoming a global leader in e-mobility is characterized by a well-orchestrated series of government interventions, heavy subsidies and tax breaks, technological innovation, and innovative policy shifts. The PRC has demonstrated that its rise in EVs is both deliberate and transformative. This shows that the early foundations of pilot programs and infrastructure investments enable the market to gain local traction. Simultaneously, the PRC continued to demonstrate its policy innovation in leveraging environmental crises for its industrial competitiveness, with a vision to consolidate and expand the EV market globally.

Benefits of Transitioning to Electric Vehicles

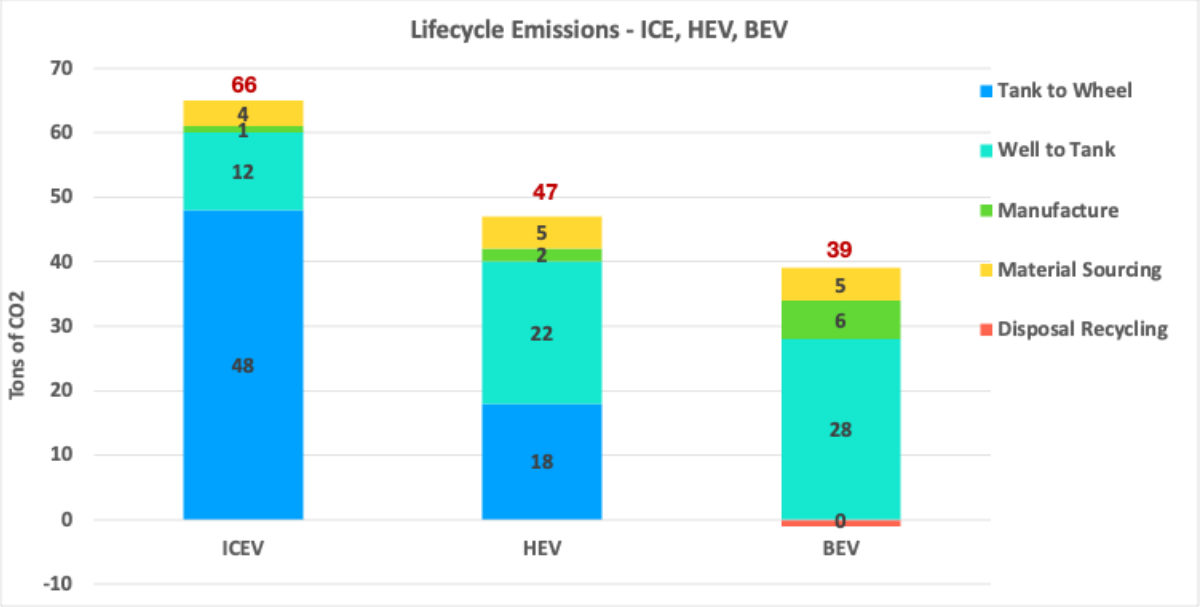
EVs are broadly categorized into three main types: BEVs, PHEVs, and HEVs. BEVs are fully electric, rely solely on batteries for power, and produce zero tailpipe emissions. PHEVs combine a battery-powered electric motor with an ICE, which allows them to operate on electricity for short distances before switching to gasoline or diesel, when required (EVgo Fast Charging, 2025). A key feature of PHEVs is that they can be externally charged, similar to BEVs. In contrast, HEVs use both electric motor and ICE but cannot be plugged in; instead, they generate electricity through an internal electricity generation mechanism powered through their ICEs or regenerative braking. While BEVs offer the highest emission reduction, PHEVs serve as a transitional solution, and HEVs provide improved fuel efficiency compared to conventional ICEVs.

Climate Benefits of EVs

To fully understand the climatic benefits of EVs, their lifecycle emissions should be analyzed. Chart 8 presents the lifecycle emission analysis of BEVs versus HEVs and ICEVs. BEVs, over their lifecycle, including manufacturing, use, and disposal, typically result in 50-70% lower emissions than ICEVs, especially in regions with cleaner electricity sources (Fuel Institute, 2022). In contrast, HEVs offer moderate reductions in emissions by combining a smaller ICE with an electric motor; however, they still produce direct emissions. As demonstrated in Chart 8, BEVs offer significant emission reductions (39 tons of CO_2 over its life cycle) compared with ICEVs (66 tons). HEVs also provide decent emission reductions, with 47 tons of CO_2 over the lifecycle.

Chart 8

*Lifecycle Emissions Analysis of Battery Electric Vehicles (BEVs) versus Hybrid Electric Vehicles (HEVs) and Internal Combustion Vehicles (ICEVs)***.**



Source: Chart generated by Author based on the data by Fuels Institute

The key to maximizing the environmental benefits of BEVs lies in the decarbonization of the electricity grid and continued improvements in battery technology. With these developments, BEVs offer the cleanest path to global transportation. In the interim, HEVs and PHEVs remain practical solutions for regions with limited charging infrastructure to ease the transition to ZEVs.

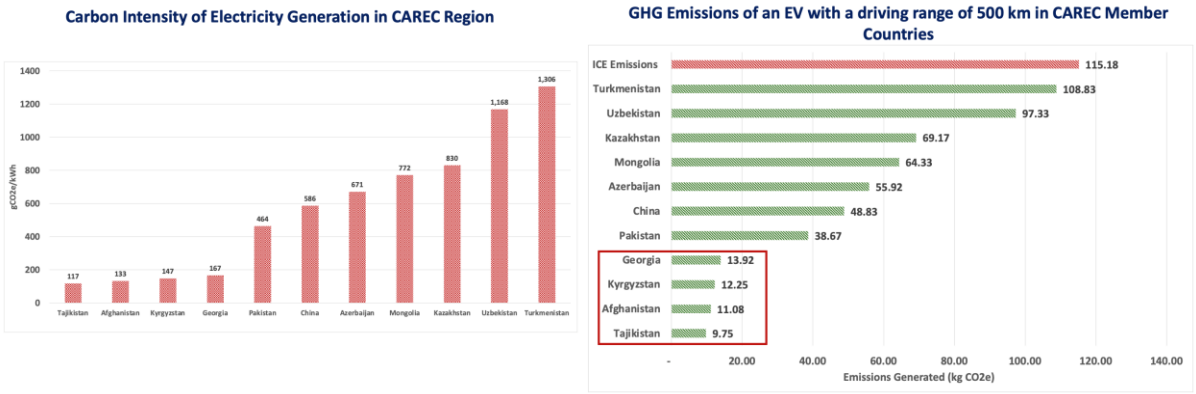
Can Electric Vehicles Keep Climate Promises for CAREC Countries?

The climate benefits of EVs in CAREC countries are highly dependent on the carbon intensity of the electricity grid and power generation and transmission. In countries such as Turkmenistan, Uzbekistan, and Kazakhstan, the current grid mix mainly consists of fossil fuel power plants, which limits the positive impact of EV adoption because of the high emissions from generating electricity for EVs. Conversely, countries such as Tajikistan, Afghanistan, Kyrgyzstan, and Georgia have cleaner grids, making them well positioned to substantially reduce GHG emissions through e-mobility owing to their low-carbon electricity grids.

Chart 9, left panel, highlights the carbon intensity of electricity generation in CAREC countries, measured in gCO_2/kWh (grams of CO_2 per kWh), indicating the cleanliness of the energy grid in each country. Countries with lower carbon-intensity grids (those relying more on renewables or cleaner energy sources, such as hydroelectricity) provide greater climate benefits when charging EVs. For instance, Tajikistan has the lowest carbon intensity at 117 gCO_2/kWh, making it one of the cleanest grids in the CAREC region.

Chart 9

Carbon Intensity of Electricity Generation (left) and GHG Emissions of EV for 500 km in CAREC Region (right)



Source: Compiled by the Author based on IEA data.

The right panel in Chart 9 shows the comparison of GHG emissions of an EV over a 500 km drive between different CAREC countries, considering the emissions from the electricity grid used to

charge the EV. The emissions were measured in kg CO_2e (kilograms of CO_2 equivalent), showing the amount of carbon dioxide released per 500 km.

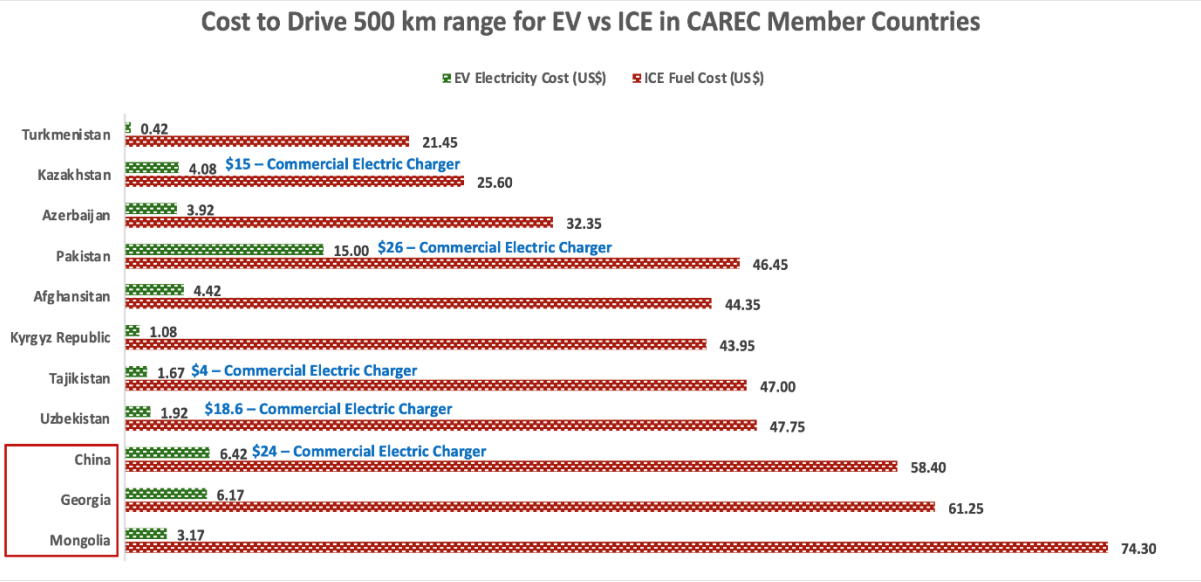
In Turkmenistan, where the grid is extremely carbon-intensive, EVs generate 108.83 kg CO_2e, offering little emissions benefit compared to that of conventional ICEV, which emit 115.18 kg CO_2e. Thus, to fully realize the climate benefits of EVs, some CAREC countries need to focus on decarbonizing their electricity grids, ensuring that EVs are powered by clean and renewable energy.

Economic Advantages of EVs for Consumers

From a consumer perspective, it is essential to compare the costs to understand the economic benefits of EVs over ICEVs in the CAREC region. Despite variations in electricity costs, EVs consistently offer significant fuel savings compared to ICEVs, as shown in Chart 10. Even in countries with more expensive electricity grid or substantially higher commercial charging costs, EVs remain a much cheaper option than ICEVs over the same driving distance.

Chart 10

Cost to Drive 500 km in EV vs. ICE in CAREC Countries



Source: Compiled by the author based on national datasets.

In countries such as the Kyrgyz Republic, Turkmenistan, and Tajikistan, EV saves a substantial fuel cost, making them a highly attractive option to consumers from a cost perspective. This underscores that beyond environmental benefits, EV adoption in the CAREC region can lead to considerable economic savings for drivers, which could be a key driver for accelerating the transition to e-mobility in these countries.

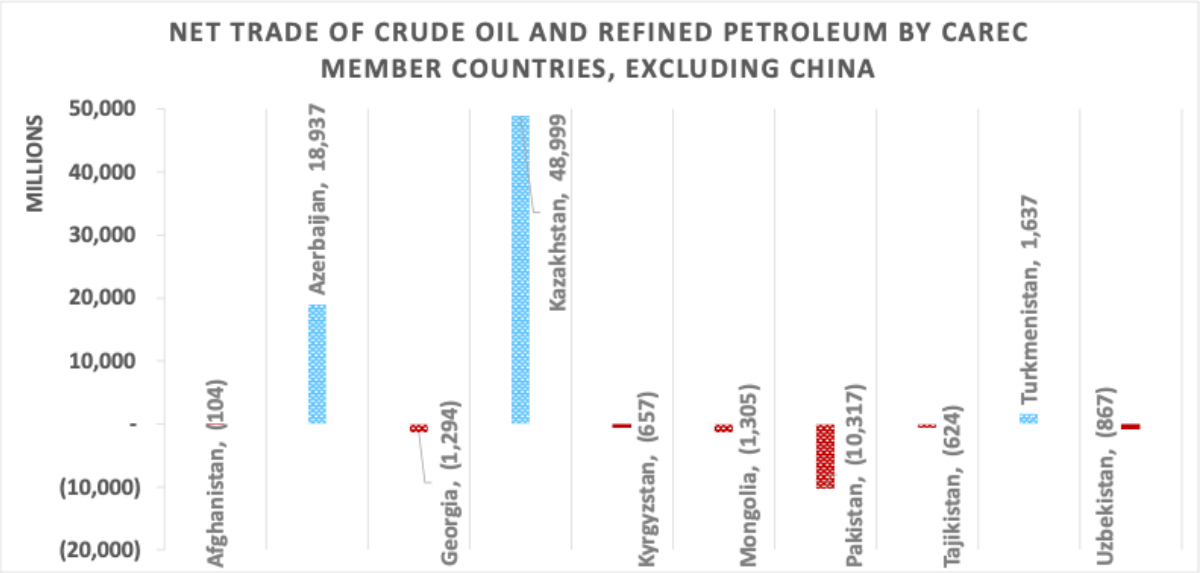
Countries with higher gasoline prices, such as the PRC, Mongolia, and Georgia, illustrate the substantial cost savings offered by EVs, strengthening the case for expanding the charging infrastructure and incentivizing EV adoption.

The Impact of Transitioning to EVs

While the PRC enjoys the dual advantage of reducing oil imports and increasing EV exports, countries such as Pakistan must embark on EV adoption with caution. The challenge lies in ensuring that savings on oil imports are not simply substituted by rising EV import costs, which could neutralize any potential foreign exchange benefits. Developing local production capabilities for EVs and their components is critical for realizing the full economic benefits of this transition.

Chart 11

Net Trade of Crude Oil and Refined Petroleum by CAREC Countries



Source: Observatory of Economic Complexity (OEC), compiled by Author.

For oil-producing countries, the shift towards e-mobility is both a challenge and an opportunity. To remain competitive in a decarbonizing world, these economies must invest heavily in diversifying their energy sectors with a particular focus on clean energy and e-mobility. These interventions will allow them to ensure long-term economic stability in the face of declining global oil demand Chart 11 presents net trade of crude oil and refined petroleum by CAREC countries.

Social Impact of EV Adoption: Opportunities and Challenges

The transition to EVs brings significant social benefits, particularly for improving public health and enhancing mobility equity. EVs contribute to lower rates of respiratory illnesses and improved air quality with zero tailpipe emissions, particularly in densely populated urban areas (Keck School of Medicine, 2023). In addition, the shift to electrified public transport and shared mobility solutions can make clean transportation more accessible and affordable for low-income communities. However, ensuring equitable access to EVs requires targeted policies, such as subsidies for low-income households, investment in public charging infrastructure, and expansion of electric buses and ride-sharing services in underserved regions.

Impact on Job Market Transformation

EVs can reshape the automotive industry and, subsequently, the job market, particularly in industries that rely on ICEV manufacturing. Traditional automotive jobs, such as engine assembly, fuel distribution, and mechanical repairs, can decline because of the simpler design and lower maintenance requirements of EVs (World Resources Institute, 2023). This transition poses a significant challenge for workers in the traditional automotive industry, as the demand for their skills diminishes.

However, EV transition also creates new employment opportunities in battery production, software development, EV assembly, and charging infrastructure deployment, with increased demand for electrical engineers, battery technicians, and technology specialists (Innovation News Network, 2024). CAREC countries and private sector players must invest in vocational training and

partnerships with universities and technical institutions to equip workers with the skills necessary for an evolving automotive landscape.

Re-Skilling and Capacity Development

Comprehensive reskilling and capacity development programs are essential for traditional automotive industry workers affected by job displacement to ensure a smooth transition to an EV-driven economy. Governments, industry leaders, and educational institutions must collaborate to develop specialized training programs focused on battery technology, electric drivetrains, power electronics, and maintenance of charging infrastructure. Vocational training centers and technical institutes should integrate EV-related curricula to equip workers with the skills necessary for emerging roles in EV manufacturing, battery recycling, and energy management systems. In addition, on-the-job training, certification programs, and apprenticeships by original equipment manufacturers (OEMs) can help workers transition from conventional automotive and energy jobs to EV services, software integration, and renewable-energy-based transport solutions (World Resources Institute, 2022). Investing in workforce development will not only mitigate job losses but also foster a more sustainable and inclusive transition to e-mobility.

The Need for Electric Vehicle Charging Infrastructure

One of the most significant hurdles for many countries, including the CAREC members, is the lack of adequate charging infrastructure to support widespread EV adoption. This challenge is particularly pronounced in the CAREC region, especially in countries such as Pakistan, Tajikistan, and the Kyrgyz Republic, with a weak grid infrastructure.

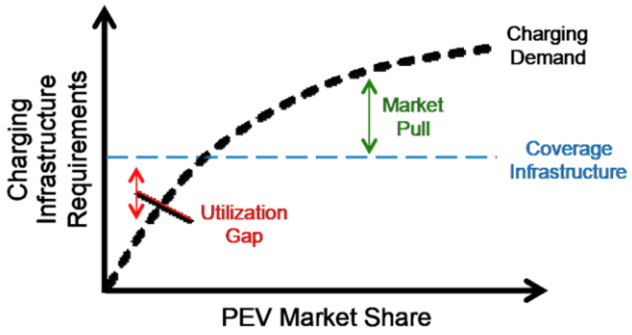
The EV-charging infrastructure presents a chicken-and-egg problem (London School of Economics, 2022). The private section is reluctant to invest in the charging infrastructure when the EV market share is low, creating an infrastructural gap. Without sufficient charging stations, consumers are hesitant to purchase EVs; however, without sufficient EVs, investors hesitate to build additional charging stations Chart 13 represents EV charging utilization gap and current state of installed EV chargers in CAREC. Therefore, investment in charging infrastructure is the key to

addressing the initial investment barrier, and the role of government-backed financing is crucial for building adequate charging networks.

To address this challenge, CAREC countries should focus on rolling out the charging infrastructure in a phased manner. They can start with basic infrastructure coverage to support early EV adopters and gradually expand as market demand increases. There are also risks of overbuilding networks and underutilizing infrastructure. To address the utilization gap, governments in CAREC countries should provide incentives, such as subsidies, tax rebates, or reduced import duties on EVs. This can help increase the market demand of EVs, which can further improve charging infrastructure utilization.

Chart 13

EV Charging Utilization Gap And Current State Of EV Chargers Installation in the CAREC Region



A "utilization gap" persists in a low vehicle density environment making it difficult to justify investment in new stations when existing stations are poorly utilized

Installed EV Chargers in the CAREC region

CARECE Economy	Charging Stations
China	1.8 million
Uzbekistan	703
Kazakhstan	380
Georgia	150
Kyrgyz Republic	150
Azerbaijan	95
Tajikistan	70
Pakistan	12

Source: International Council on Clean Transportation (ICCT), EV charger data compiled by the author. *Passenger Electric Vehicles (PEV)*

The PRC has established an extensive charging network, with 1.8 million chargers, that offers valuable lessons for other CAREC countries. By prioritizing infrastructure investments early, the PRC has fostered widespread EV adoption. Other CAREC countries can refer to the PRC model for guidance on effectively scaling their own networks.

Addressing Range Anxiety to accelerate EV Adoption

Although home charging currently meets most EV demands, the expansion of publicly accessible charging infrastructure is essential for providing the same level of convenience and accessibility as that of refueling conventional vehicles. Range anxiety remains a significant barrier to EV adoption because drivers fear running out of charge without access to a reliable charging network (Abdul Qadir et al., 2024).

In dense urban areas, the need for public charging infrastructure is particularly pronounced owing to the prevalence of apartment buildings and limited access to private charging facilities (Greening the Grid, 2025). In these areas, expanding the availability of public charging is critical for supporting the widespread adoption of EVs.

Home charging can satisfy most of the needs of consumers who primarily drive short distances and reside in detached houses. Charging overnight with a slow charger, which typically takes 10–12 h to fully recharge an EV for a 500 km range, is a cost-effective solution, as residential electricity rates are generally the lowest (International Energy Agency, 2024).

However, for those who frequently travel long distances—particularly commercial vehicle operators or individuals embarking on trips exceeding 500 km—the availability of fast chargers on highways is crucial. High-power charging stations on interstate routes ensure minimal downtimes and enhance the practicality of EVs for long-range travel.

To optimize the charging infrastructure deployment while minimizing costs, city planners should prioritize slow public chargers in urban areas. These chargers are more economical, require lower capital investment, and reduce the stress on the power grid owing to their lower energy demand. Ideally, public chargers should be installed in locations where vehicles are parked for extended periods, such as workplaces, shopping malls, hotels, and schools, to ensure accessibility and convenience for EV users.

Types of EV Chargers

EV chargers are broadly categorized into slow and fast chargers:

Slow chargers: These are rated below 22 kW and typically require 10–12 h to fully charge an EV. Residential chargers, which are commonly rated at 7 kW, are ideal for overnight home charging and workplace installations (Pod Point, 2024). Despite taking longer to charge, they are the most economical in terms of electricity consumption and are beneficial for battery health because they generate less heat.

Fast chargers: Typically rated at 50 kW, these significantly reduce the charging time. Superchargers or rapid chargers rated at 150–350 KW and above can charge an EV by up to 80% in less than 30 min, making them ideal for long-distance travel (Motoring Electric, 2024). However, these chargers are significantly more expensive in terms of capital investment and operational costs.

The selection of an appropriate charging infrastructure depends on factors such as housing type (detached homes versus apartments), driving patterns, and workplace charging priorities. Globally, some countries invest heavily in fast chargers, whereas others prioritize slow chargers owing to economic and grid considerations.

Demand Planning and Optimal Number of EV Chargers for the CAREC Region

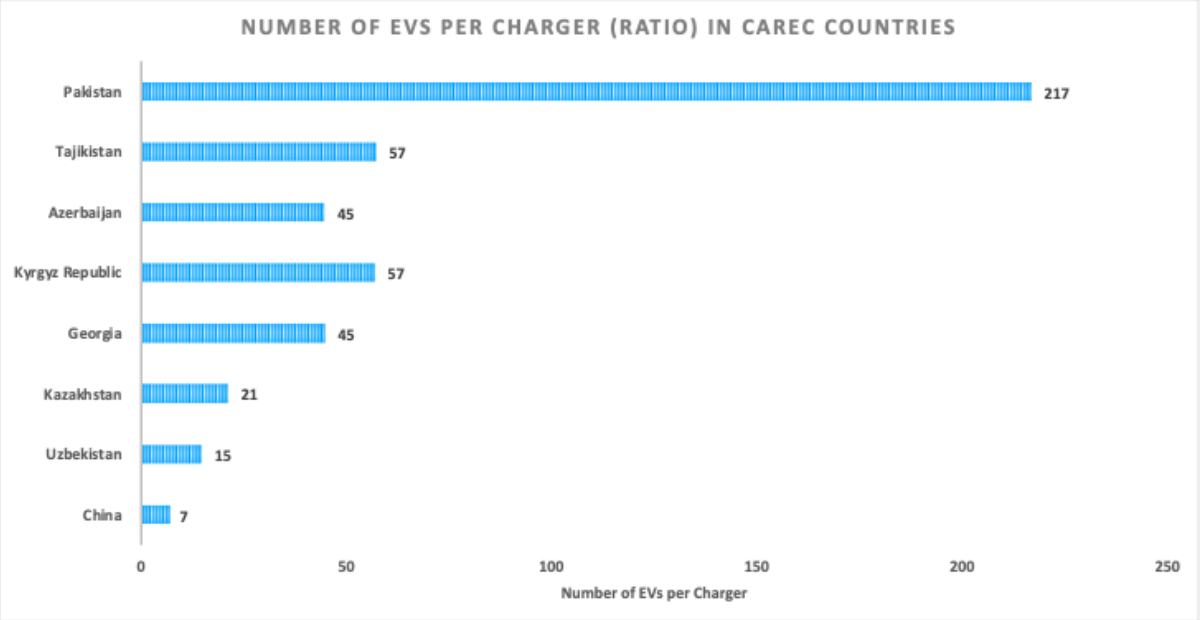
One way to assess the adequacy of the EV charging infrastructure is by examining the ratio of EVs to public chargers. The EU recommends an ideal ratio of 10 EVs per public charger (EVAdoption, 2019). However, this ratio varies widely across regions. For instance, Norway and Denmark have over 30 EVs per charger, whereas the UK and US have 20 and 18 EVs per charger, respectively (Chart 14) (Sustainability by Numbers, 2023).

Cities also exhibit varying approaches to EV-charging infrastructure. In the US, cities such as San Jose, San Francisco, and Los Angeles have high EV adoption rates with relatively fewer public chargers. This is because many residents have private garages or driveways that allow home and workplace charging.

Conversely, high-density cities, such as Amsterdam, London, and Paris, where many people live in apartments without access to home charging, require extensive public charging infrastructure.

Chart 14

EVs to Charger Ratio in the CAREC Region



Source: Author's analysis based on EV stock Trade Map; Number of EV Chargers' data compiled by the author.

In CAREC countries, the demand for charging infrastructure depends on urban planning and housing stock. Resource-constrained countries should prioritize cost-effective slow chargers in homes and workplaces to reduce their reliance on fast chargers for in-city travel. Fast chargers should be prioritized along highways to support long-distance travel. Considering the global trends, CAREC countries should aim to build a charging infrastructure with the ratio of 20-30 EVs per charger.

Promoting Private Sector Investments in Charging Infrastructure

Charging infrastructure investment also faces a classic chicken-and-egg dilemma: private players hesitate to invest without substantial EV adoption, while consumers are reluctant to switch because of limited charging availability. The primary driver of private sector investment is the

growing consumer demand for EVs, which depends on factors such as purchase prices, operational costs, and policy incentives. Countries with low electricity tariffs, zero import duties on EVs, and reliance on imported fuels have seen faster EV adoption in the CAREC region, making investments in charging stations more attractive. As early adopters drive the market momentum, private players recognize opportunities and enter the sector. However, in the initial stages, government support is crucial for developing a basic charging infrastructure through targeted subsidies, PPPs, and regulatory incentives. Private investors can further leverage green financing mechanisms such as carbon credits and low-interest loans to accelerate infrastructure deployment.

Impact of Cold Climate on Electric Vehicle Performance

The performance of EVs tends to decline in extremely cold temperatures. At -20 °C, the battery range of EVs may reduce by 10-20% and charging times may increase due to inherent battery chemistry limitations (Scientific American, 2025). However, EVs can operate effectively under cold conditions. For instance, when temperatures drop to -7 °C, an EV's average driving range decreases by 12% compared to its range at 24 °C (Sustainability by Numbers, 2023). Some EV models, such as Tesla, feature preconditioning, a system that heats or cools the battery to the optimal charging temperature, thereby improving efficiency in extreme weather conditions.

Several areas in Central Asia, including Tashkent (Uzbekistan), Dushanbe (Tajikistan), and Astana (Kazakhstan), frequently experience temperatures as low as -20 °C (Radio Liberty, 2023). To assess whether extreme cold significantly hinders EV adoption, we examined Scandinavian countries where EV adoption rates remain high despite severe winters. Finland and Sweden have successfully integrated EVs into their transport sectors, and Canada has tested EVs in -37 °C, proving their resilience in extreme cold (Left Coast EV, 2024).

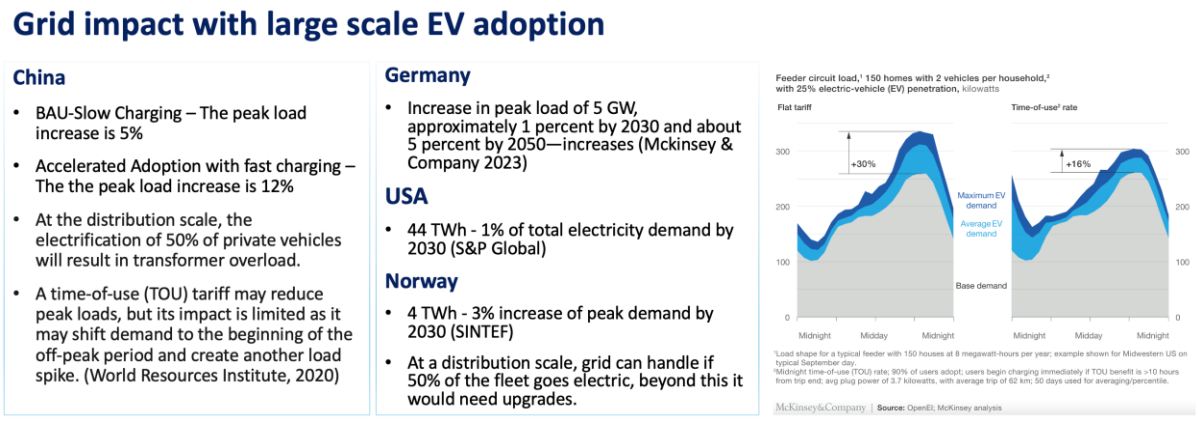
Thus, although cold temperatures may pose challenges for some CAREC countries, they are unlikely to be a major barrier to EV adoption. A potential transitional solution is the adoption of PHEVs, which allow drivers to switch to ICEs in extremely cold conditions while preserving battery health.

Impact of Widespread EV adoption on the Electricity Grid

As EV adoption accelerates, countries must address additional electricity demand, particularly during peak load times, to ensure that national grids remain resilient. Chart 15 presents an analysis of the grid impact of large-scale EV adoption in leading economies including the PRC, Germany, the USA, and Norway. In most macro-level analyses, the impact of EV adoption on national grid systems is not expected to pose a significant challenge. Countries such as the PRC, Germany, the USA, and Norway can handle the increased electricity demand from EVs at the national level. For example, the projected EV growth in Germany would add only approximately 1% of the total electricity demand at 5 gigawatts (GW) of generation capacity by 2030 (McKinsey & Company, 2018). Likewise, in the USA, S&P Platts analytics outlook data suggest that the total electricity demand for EVs will reach 44 terawatt-hours (TWh) in 2030 (S&P Global, 2020), which is less than 1% of the total electricity demand (U.S. EIA, 2020). However, EVs still contribute to peak load increases, particularly at the distribution level where local systems may be more vulnerable to overloads.

Chart 15

Grid Impact for Large Scale EV Adoption in Leading Economies



Although national grids can easily accommodate the additional electricity demand from large-scale EV adoption, local distribution networks would face more immediate challenges, particularly during peak load times. Thus, CAREC countries must focus on grid strengthening, leveraging time of use (ToU) tariffs, and managing charging behavior to ensure a smooth transition

to e-mobility. By planning early and investing in smart grid infrastructure, potential bottlenecks can be avoided, and the benefits of EV adoption can be realized without compromising grid stability.

Recycling and Disposal of Lithium-Ion Batteries

The LIBs used in EVs have an average lifespan of approximately 10 years (MIT, 2024). With the mass adoption of EVs in the coming years, CAREC countries may face environmental and technical challenges regarding the disposal of these batteries once they reach the end of their useful lives. There are three primary options for handling batteries: a) disposal, b) recycling, and c) repurposing.

a) **Disposal**

In countries with less stringent environmental regulations, LIBs may be disposed of in landfills. However, this is highly detrimental to the environment because batteries contain toxic materials that can contaminate soil, water resources, and biodiversity. Appropriate disposal regulations are essential to prevent environmental degradation. CAREC countries should develop robust environmental regulations to prevent battery disposal in landfills without proper monitoring.

b) **Recycling**

Many countries have environmental regulations that require LIBs to be recycled for environmental and economic advantages. LIBs contain valuable materials such as cobalt, manganese, and nickel. Recycling is economically viable when a significant cost gap exists between procuring new raw materials and recycling (McKinsey & Company, 2019). Given the limited global supply of rare metals, recycling offers opportunities for economic and environmental sustainability. For instance, processing one metric ton of used LIB can cost approximately US$ 90, with recovered materials selling for US$ 300 or more. High-value metals could gain over US$ 500 per ton, making recycling profitable (Curran, 2021).

c) **Repurposing**

Used LIBs can be repurposed for stationary energy-storage applications, particularly

in renewable energy systems that require less stringent performance standards. However, standardization challenges exist because battery sizes, specifications, and designs vary across EV models, making large-scale repurposing challenging for second-life applications.

Policy Recommendations

The transition to e-mobility in the CAREC region offers a strategic opportunity to decarbonize the transport sector, reduce dependence on fossil fuels, and align with national and global climate goals. Despite the potential for EV adoption, key challenges, such as high upfront costs, limited infrastructure, and the need for policy coherence, require action. To ensure successful transition, CAREC countries must adopt comprehensive policies that address both economic and infrastructural barriers. Careful planning and implementation of these policies can help promote sustainable transport growth and cleaner and more resilient infrastructure development in the region.

1. **A holistic avoid-shift-improve strategy should be adopted to define clear national EV adoption targets in line with broader climate objectives and integrate these goals into national decarbonization strategies.** Planners must design cities that naturally minimize the need for frequent travel to encourage more sustainable mobility patterns. Urban planning that promotes walkability and cycling infrastructure can reduce the dependence on motorized transport, enabling more livable and environmentally friendly cities.
2. **Higher purchase cost remains the key barrier in EV adoption.** Hence, CAREC economies should strengthen fiscal and non-fiscal incentives such as import duty exemptions, tax subsidies, and preferential loans to make EVs more affordable and accessible.
3. **Investing in a charging network would support early EV adopters by providing basic coverage** and encourage private sector investment in charging infrastructure for long-term market growth.

4. **Carbon credits can be used as a financing tool to support widespread EV adoption** in CAREC countries to fulfill climate commitments under international climate agreements.
5. **Electrifying public and government fleets**, **public transport, and commercial vehicles**, including taxis and ride-hailing services, can be a low-hanging fruit to boost demand and reduce emissions.
6. **Electricity demand can be managed by implementing TOU tariffs** to incentivize off-peak EV charging, ease grid demand, and facilitate the smooth integration of EVs into national energy systems.
7. **Governments should fund or co-invest in basic charging infrastructure** to break the chicken-and-egg cycle to minimum coverage to encourage EV adoption and attract private sector investment.
8. **Private investment can be promoted through tax incentives**, grants, and subsidies for investing in charging stations, particularly in high-demand areas such as urban centers, highways, and commercial hubs.
9. **Clear EV charging regulations**, including pricing frameworks, grid access policies, and land-use permissions should be established to create a stable business environment for private sector investors.
10. **Low-interest loans, carbon credit trading, and green bonds** can help private investors finance the charging infrastructure and integrate renewable energy solutions into charging networks.
11. **Governments should prioritize the deployment of high-power fast chargers** along major highways and interstate routes to support long-distance travel for both commercial and private EV users, thereby ensuring minimal downtime and enhancing EV practicality.
12. **City planners should focus on deploying slow public chargers in urban areas** to minimize costs and grid stress; prioritize locations such as workplaces, shopping malls, hotels, and schools where vehicles remain parked for extended periods; and ensure accessibility and convenience for EV users.

13. **Robust environmental regulations should be established to prevent direct disposal of used batteries.** A significant number of EV batteries reach the end of their lifespan in 7-10 years and require proper recycling or repurposing. Given the economic value of recycling and the demand for energy storage solutions, governments should promote battery recycling programs to address the supply gap of critical metals, while also supporting second-life applications for renewable energy storage and stationary power solutions.

Country-Specific Policy Recommendations

The transition to e-mobility presents unique opportunities and challenges for CAREC countries. Each country must leverage its unique strengths and address specific challenges in decarbonizing transportation and promoting EVs. Following are some specific recommendations:

- **The PRC should establish regional partnerships for LIB assembly and EV manufacturing,** maintain its leadership in the EV sector, and promote exports from CAREC countries to global markets.
- **Uzbekistan and Kazakhstan need to establish themselves as EV production centers** and export hubs in Central Asia.
- **Tajikistan should utilize carbon financing to capitalize on the clean energy grid**, drive EV adoption, and advance green innovation in the industrial sector.
- **Turkmenistan should focus on grid decarbonization** to further enhance the sustainability of EV adoption.
- **Afghanistan and Kazakhstan may** partner with Chinese mining corporations to explore lithium-ion deposits, strengthen the battery supply chain, and support regional EV development.
- **Kazakhstan, Turkmenistan, and Azerbaijan should diversify fossil fuel revenues** into a green economy, with a focus on transport electrification. Turkmenistan should prioritize grid decarbonization.

- **Kazakhstan, the Kyrgyz Republic, and Tajikistan,** as colder regions with limited charging infrastructure, may prioritize PHEV adoption to facilitate the transition to e-mobility.
- **Pakistan should focus on the large motorbike market and affordable compact EVs,** starting with battery assembly for electric bikes. Initial import duty relaxation will help build market momentum, whereas localization through joint ventures with Chinese manufacturers will strengthen supply chains.

CAREC countries can accelerate their e-mobility transition, reduce emissions, and contribute to a sustainable future for the region. As countries continue to pursue e-mobility goals, policy incentives such as import duty waivers, tax exemptions, and preferential loans are crucial. Additionally, strengthening the EV charging infrastructure and promoting regional trade partnerships can further accelerate EV adoption and advance the region's decarbonization objectives.

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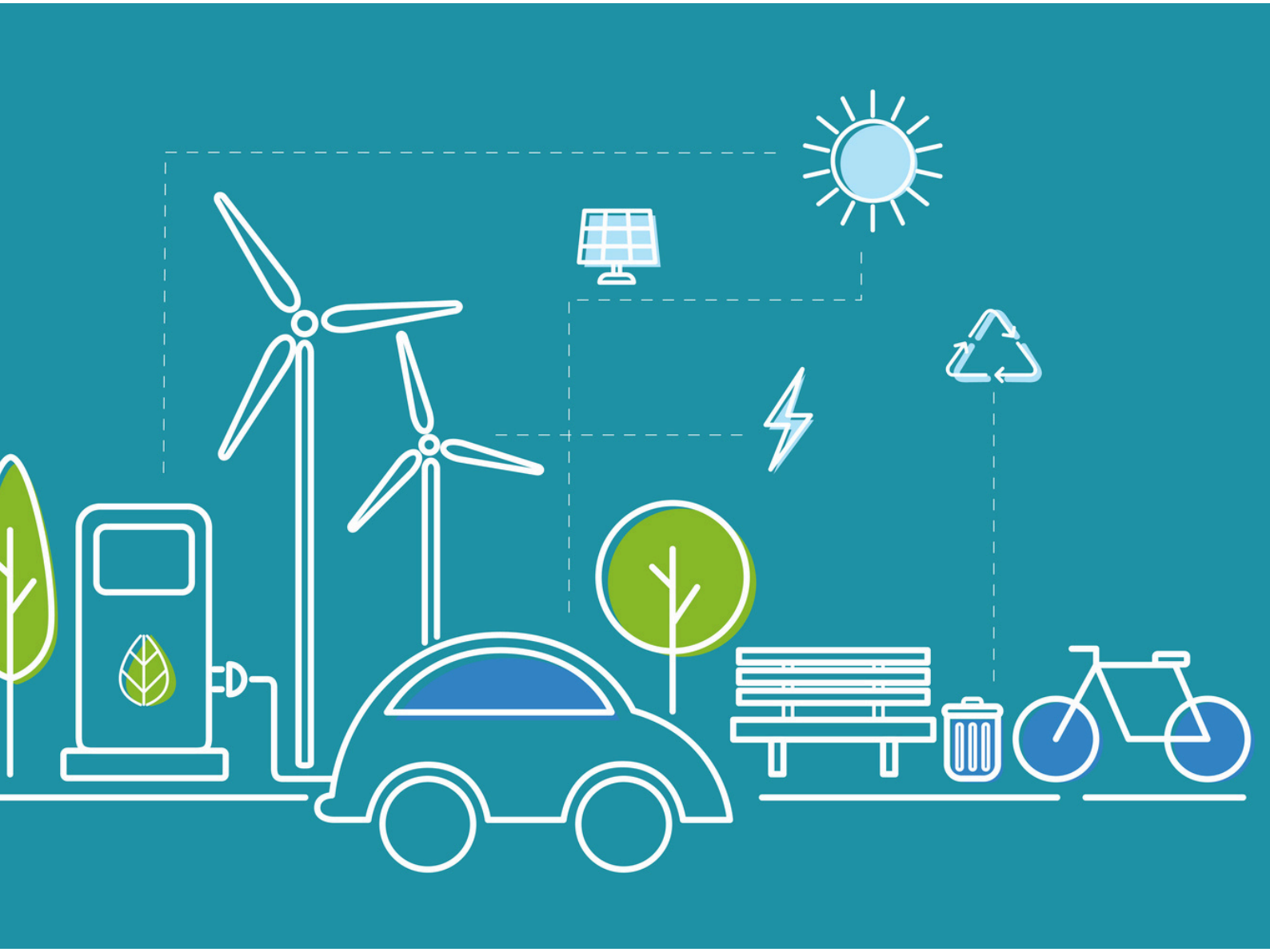

+86.991.8891151

km@carecinstitute.org | www.carecinstitute.org

21th Floor, Commercial Building Block 8, Vanke Metropolitan,
No. 66 Longteng Road, Shuimogou District,
Xinjiang Uygur Autonomous Region, the People's Republic of China , 830028