Reducing Emissions and Building Resilience in the Transport Sector
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1. Context

In terms of total final energy consumption, the transport sector is the third largest consuming sector in Kazakhstan (at 18%) after the residential sector (33%) and industry (32%), as of 2020. This is a reflection of the role the sector plays - mobility of people and moving freight, by land, rail, sea and air, which are pre-requisites for functioning of the Kazakhstan economy. Transport sector energy consumption has been increasing (in absolute terms) in the past decade (alongside GDP), and since 2010 energy use had grown almost 60%. Energy efficiency of the transport sector is low, as vehicle fuel economy standards and import bans on older vehicles are not effectively enforced, and robust emissions testing regimes are lacking. No comprehensive policies have yet been developed to target emissions in the transport sector.  

Fossil fuel consumption is the key driver of emissions in Kazakhstan transport sector. Oil-based fuels dominated energy consumption in 2020 (motor gasoline 65%, diesel 19%). Liquid Petroleum Gas (LPG) has been used in the transport sector since 2013, though mainly in the western regions of Kazakhstan, where increases in gas prices reportedly led to civil unrest in January 2022. In 2020, gas represented 11% of energy consumption in the transport sector. Consumption of electricity (mostly in rail), was 3% in 2020.  

Over the period from 1990 to 2019, transport emissions (GHG equivalent) as a percentage of total Greenhouse Gas (GHG) emissions, fluctuated between about 4 and 7 percent, showing an increasing trend over the last decade to about 7.1% in 2019 (see Figure 2). Absolute values of GHG equivalent emissions from the transport sector are shown in Figure 1. Disaggregating the transport emissions by mode, in 2019 87% of the GHG emissions from the transport sector were from the road sub-sector, and that proportion has remained reasonably steady over the preceding decade (refer Figure 3). Over the decade to 2019, emissions from aviation (domestic and international) averaged 7.8%, rail averaged 3.4%, and shipping (domestic and international) averaged less than 1%. Emissions from other transport modes are negligible. It is therefore clear that reducing GHG emissions from the road sector will have the most impact overall in the transport sector in Kazakhstan.

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2 Ibid
3 World Bank calculations based on IEA fuel sales data. GHG equivalent emissions.
2. **Commitments to Reduce Transport Sector Emissions**

“Kazakhstan 2050: A New Political Course of the Established State”, also known as “Strategy 2050,” sets guidelines for building a sustainable and efficient economic model based on the country’s transition to a green development path. In terms of the Transport sector, it aims to renew over 80 percent of its road vehicle fleet, which if implemented would provide significant opportunity to introduce cleaner vehicles. Eighty percent of the road transportation vehicles are more than 10 years old; and fuel quality is poor compared with the European levels.

Strategy 2050 envisages that renewable energy sources will provide 50% of all energy by 2050. To achieve this, the country will need implementation of comprehensive policies, because significant energy sector

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4 World Bank calculations based on Climate Analysis Indicators Tool (CAIT) from ClimateWatch.org
5 Aviation and shipping include domestic and international modes.
6 2013, Concept for transition of the Republic of Kazakhstan to Green Economy
subsidies will otherwise impede the transition. In the transport sectors, subsidy schemes for oil products keep end-user prices low, below their full cost of supply.\textsuperscript{7} However, targeting such subsidies pose an enormous political and social challenge as was evidenced by demonstrations in Kazakhstan in early January 2022, which was triggered by increases in the price of liquefied petroleum gas, used as a car fuel in some parts of Kazakhstan.

Kazakhstan has set unconditional and conditional (on international support) targets to reduce GHGs by 15% and 25%, respectively, by 2030 compared with 1990. Kazakhstan has also made a noteworthy claim to achieve carbon neutrality by 2060. Kazakhstan’s nationally determined contributions (NDC) commitments in relation to the transport sector, are shown in Table 1.

<table>
<thead>
<tr>
<th>Emission Targets</th>
<th>National policy/strategy\textsuperscript{8}</th>
<th>Cost of Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unconditional</td>
<td>Conditional \textsuperscript{9}</td>
<td></td>
</tr>
<tr>
<td>15% absolute economy-wide reduction in GHG emissions by 2030 compared to the (baseline) of 1990</td>
<td>• Development of sustainable and “smart” transport&lt;br&gt;• Sustainable Urban Mobility&lt;br&gt;• Development of alternative modes of transport and related infrastructure, - in particular, for electric vehicles and gas vehicles&lt;br&gt;• Improvement of traffic management system&lt;br&gt;• To date, Kazakhstan has not taken participated in the CORSIA\textsuperscript{10} nor taken part in IMO\textsuperscript{11} initiatives.</td>
<td>According to the Concept for Transition of RoK to Green Economy, the average annual need for green economy funding amounted to USD 3.1 billion for 2017-2018, which is 1.23 % of GDP.\textsuperscript{12}</td>
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</table>

As summarized in Table 1, Kazakhstan’s report to the United Nations Framework Convention on Climate Change (UNFCCC) in 2019\textsuperscript{13}, described various policies and measures to reduce emissions in the transport sector. This included the development of electric and gas vehicles, and related infrastructure, and noted that the costs of e-vehicles and lack of charging station infrastructure was impeding wider implementation of electric mobility. For example, in 2019, only 696 electric vehicles were registered in Kazakhstan. The Report to UNFCCC also set out ambitions for upgrading buses and service vehicles to use compressed and/or liquefied natural gas, and to construct more gas-filling compressor stations. Other measures included improving the traffic management systems in primary cities, in order to reduce traffic delays and increase the operational speed of public transport; and increased digitalization through Smart Transport Systems (such as electronic ticketing, traffic management and parking management systems). At the time,

\textsuperscript{7} 2014, OECD, Energy Subsidies and Climate Change in Kazakhstan
\textsuperscript{8} Based on fourth biennial report [https://unfccc.int/sites/default/files/resource/Report_BR4_Updated.pdf](https://unfccc.int/sites/default/files/resource/Report_BR4_Updated.pdf). Note that KZ is still INDC
\textsuperscript{9} Conditional on International Support
\textsuperscript{10} CORSIA - Carbon Offsetting and Reduction Scheme for International Aviation
\textsuperscript{11} IMO – International Maritime Organization
\textsuperscript{12} Based on fourth biennial report [https://unfccc.int/sites/default/files/resource/Report_BR4_Updated.pdf](https://unfccc.int/sites/default/files/resource/Report_BR4_Updated.pdf). Note that KZ is still INDC
these measures were forecast by the Government to reduce emissions by up to 24%, although this has not been verified.

The transport sector plays an important role in ensuring that the GHG reductions are achieved. However, the heritage of the Former Soviet Union in transport was marked by an energy-intensive industry reliant heavily on carbon-based transport modes and natural resources with high level of subsidies. Key barriers for sustainable transport development in Kazakhstan include - lack of policy and infrastructure to support the introduction of clean vehicles, fossil fuel subsidies, lax tailpipe emission norms, poor fuel quality standards, and inadequate pricing signals.

In line with the NDCs, according to the 2021-22 Draft Doctrine (Strategy) prepared by the Ministry of Ecology, Geology and Natural Resources; electricity will increasingly dominate final energy consumption and cover 72% of all energy demand in transport by 2060.

With various commitments made, it is timely for Kazakhstan to now develop mitigation strategies to reduce transport sector emissions, whilst maintaining mobility, and trade connectivity. Concerted efforts will be needed to shift to low or zero emissions vehicles to meet the decarbonization targets, but other measures can also be taken to decarbonize the sector. Three main areas have been reviewed as a means to reduce energy consumption and GHG emissions from the transport sector in Kazakhstan. The first is through the introduction of emobility; the second presents options to reduce emissions in the urban setting, focusing on key cities; and the third identifies options to reduce emissions for freight - domestically, internationally, and in transit through Kazakhstan.

3. Summary of Measures and Costs to Reduce Emissions in the Transport Sector

Besides presenting the overall energy modelling results for the transport sector, the analysis in this section also touches on the main emitting transport modes, and looks at the broad options to reduce total emissions in the transport sector. As described elsewhere in the main report, the power sector nearly fully decarbonizes by 2050, contributing to decarbonization of the transport sector by 2060. The corresponding upstream production of electricity and the increase in supply of low-emissions electricity, is dealt with elsewhere in this report.

Based on technology cost curves, the energy modelling for the transport sector results in a substantial shift to battery-electric vehicles (BEV) for road transport, staring from 2030. In other transport modes decarbonization is driven by different technologies: rail is decarbonized through electrification; aviation with a shift to sustainable aviation biofuels. In the conservative World Bank modelling case, a limited shift of energy use to hydrogen happens for buses and freight (less than 1% hydrogen), while most of the buses and heavy vehicle freight are electrified. Overall battery BEV is currently a key zero-emissions technology for passenger vehicles. Although hydrogen fuel cell technology may become more prominent in trucks with high range requirements, this is not currently reflected in the modelling, as the technology is still developing.

Figure 4 shows the overall energy modelling for the transport sector including aviation, and Figure 5 shows the same but excluding aviation. Figure 4 reflects biofuels as an energy source for aviation. The shift to electricity for road transport is premised on a substantial shift to battery-electric vehicles (BEV), as the use of hydrogen fuel cell-electric vehicles (FCEV) is forecast to be limited. Battery BEV is currently a key
zero-emissions technology for passenger cars, although fuel cell technology may become more prominent in trucks with high range requirements. In aviation, there is a shift to liquid bio-fuels. In aviation beyond the switch to sustainable aviation fuel (ie biofuels), emissions may also be reduced by shifting short-haul passenger and freight trips from air to rail, retiring older aircraft and retrofitting existing fleets with energy-efficient features.¹⁴

![Figure 4 – Transport Fuel Switching in Net Zero Emissions scenario, including Aviation (PJ)](image1)

![Figure 5 - Transport Fuel Switching in Net Zero Emissions Scenario, excluding Aviation (PJ)](image2)

With reference to Figure 6, road transport energy consumption decreases from 248 PJ in 2020 to 132 PJ in 2060 (due to electrification of road transport and more efficient BEVs), with liquid fuel consumption (oil) decreasing from 234 PJ in 2020 to zero by 2060. Energy consumption in aviation increases from 35 PJ in 2020 to 136 PJ in 2060, reflecting the switch to biofuels by 2060. To illustrate this further, Figure 6 shows the switch in fuel consumption in overall road transport (including cars, trucks, buses, vans, 2 and 3 wheelers) and Figure 7 shows the switch in fuel consumption in aviation.

¹⁴ McKinsey; The net-zero transition - What it would cost, what it could bring, Brussels January 2022.
Given the uncertainty of hydrogen technology adoption in Kazakhstan, we note that the role of hydrogen in heavy duty transport and buses may become larger than the conservative assumption used in the World Bank model. Hydrogen can have a key role as an energy source for buses and heavy-duty road freight, benefitting from its higher energy density, lighter fuel cell and storage weight compared to batteries, along with shorter refuelling times. For example in a *Hydrogen4EU* study\(^{15}\) by 2050, the majority of the truck and bus fleets in circulation could be powered by fuel cells. Further Kazakhstan-specific analysis is required to understand the potential of hydrogen fuelled transport in the country.

The costs associated with transitioning to a BEV fleet were explored in the modelling, and are presented in Figure 8. It should be noted this mainly reflects estimates of the private sector cost to purchase a new fleet of NZE vehicles. Interestingly, the net difference between NZE and BAU costs is a fraction of the NZE case (shown in red in Figure 8).

\(^{15}\) [https://www.hydrogen4eu.com/_files/ugd/2c85cf_69f4b1bd94c5439f9b1f87b55af46afd.pdf](https://www.hydrogen4eu.com/_files/ugd/2c85cf_69f4b1bd94c5439f9b1f87b55af46afd.pdf)
Although most of the costs to transition to a BEV fleet will be through the private sector, the Government could develop a range of incentivization policies. Incentivisation options are presented in Section 5.1, but the relative benefits in terms of the costs of these incentivisation policies in comparison to the emissions reductions, has not been studied, and could form part of the studies needed going forward.

To facilitate the transition to BEVs, deployment of electric charging stations needs to be addressed. The costs to roll out BEV re-charging systems were modelled and are shown in Figure 9. To manage deployment, the Government might consider incentivizing some portion of the roll-out of EV charging stations. The business model for this has not been studied, and could form part of the studies needed going forward. World Bank analysis\textsuperscript{16} shows that internationally, public support for charging infrastructure has been much more effective than consumer purchase subsidies in promoting BEV adoption.

In terms of the rail sector, about 26%\(^\text{17}\) of the rail network is already electric, and Kazakh Temir Zholy (KTZ – Kazakhstan’s state-owned Rail Company), is proposing to electrify a further 1,012 km of rail network, critical to international transit of freight through Kazakhstan. KTZ’s estimate of the cost of this electrification is $1.35 billion\(^\text{18}\) over the next 5 years. A range of options to make existing (non-electrified) rail operations more efficient are discussed in Section 7.

In terms of urban transport and public transit, a number of measures exist beyond transitioning to personally-owned BEV, including motivating a modal shift towards public transport and non-motorized mobility, through improved service levels and expansion of the public transport networks; and other measures to encourage active mobility, and/or to reduce the overall number of km travelled. Some of these options are explored further in Section 6.

Given the low contribution of shipping to overall emissions in Kazakhstan, this sub-sector is not addressed in this report. With the possibility of increased shipping through the Caspian Sea, options to reduce emissions in the maritime sector could form part of the studies needed going forward.

Based on the energy modelling, and the research done and outlined in this report, the key policy options and measures are summarised below in Table 2. Note that these are options, and cost-benefit analyses have not been conducted.

<table>
<thead>
<tr>
<th>Possible Measures - EMobility</th>
<th>Suggested Time-Frame</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incentivization strategies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Motorisation management - Renew old, polluting vehicles by creating scrapping programs</td>
<td>Decade 1</td>
<td></td>
</tr>
<tr>
<td>- Registration tax rebates</td>
<td>Decade 1</td>
<td></td>
</tr>
<tr>
<td>- Income tax discounts</td>
<td>Decade 1</td>
<td></td>
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<tr>
<td>- Differentiated vehicle taxes based on emissions</td>
<td>Decade 1</td>
<td></td>
</tr>
<tr>
<td>- Mandatory targets for BEV sales</td>
<td>Decade 1</td>
<td></td>
</tr>
<tr>
<td>Policy levers to ensure that BEV’s are imported on the second-hand market.</td>
<td>Decade 1</td>
<td></td>
</tr>
<tr>
<td>Dis-incentivising internal combustion engine (ICE) vehicles— eg, Reduction / removal of fossil fuel subsidies</td>
<td>Decade 1</td>
<td>The cost/benefit of various types of incentivisation strategies needs to be further evaluated.</td>
</tr>
<tr>
<td>Green public procurement – Gov’t fleet becomes electric</td>
<td>Decade 1</td>
<td></td>
</tr>
<tr>
<td>More stringent vehicle fuel standards</td>
<td>Within 5 years</td>
<td></td>
</tr>
<tr>
<td>More stringent vehicle emissions standards</td>
<td>Within 5 years</td>
<td></td>
</tr>
</tbody>
</table>

\(^\text{17}\) Total rail network 16,040 km, with 4,216 km electric, as of 2019. “Railway Sector Assessment for Republic of Kazakhstan, March 2021; CAREC.

\(^\text{18}\) Excluding electric locomotives and lighter wagons.
### Possible Measures – Recharging Facilities

| Contribution to the initial deployment of publicly accessible recharging facilities | Decade 1 | The cost/benefit of various types of strategies to provide recharging facilities needs to be further evaluated. |
| Incentives for installation and retro-fitting of recharging facilities in private homes and office buildings | Decade 1 |
| Long-term strategy for reducing emissions in the trucking sector (and roll-out of recharging facilities) | Decade 1 |

### Possible Measures – Urban Transport

| Urban mobility modelling and sustainable transport planning in major cities | Within 5 years |
| Urban air quality modelling – to identify the transport contribution to air quality. |
| Expansion of public transit based on the modelling and planning above. | Decade 1 and ongoing |
| Expansion of infrastructure to safely accommodate active travel modes, based on the planning above | Decade 1 and ongoing |
| Transition of the existing bus fleets to electric buses in urban areas | Decade 1 |
| Incentivize micro-mobility (scooters, bike-sharing, e-bikes) | Within 5 years |
| High-impact public information campaigns to promote environmental, health and economic of using sustainable travel modes (public transport, bicycle, walking) | Within 5 years |
| Dedicated infrastructure (lanes, parking) for cycling and micro-mobility | Decade 1 |
| Dedicated bus-only lanes to reduce travel times and increase service predictability | Decade 1 |
| Re-consider urban parking – charges, restrictions, enforcement | Within 5 years |
| Consider congestion-charging and creation of low emission zones in dense city areas | Within 5 years |
| Introduce high-occupancy lanes, initially including use by low-emissions vehicles | Within 5 years |
| ITS and smart traffic control schemes | Within 5 years |
| Real-time bus information systems | Within 5 years |
| Traffic signals that prioritize pedestrians, cyclists and buses at critical intersections | Within 5 years |
| More stringent vehicle fuel standards | Within 5 years |
| More stringent vehicle emissions standards. | Within 5 years |

### Possible Measures – Freight

| Rationalization and electrification of the rail network, where feasible. | By 2040 |
| Energy-efficient locomotives, wagons with reduced tare weight, as well as technologies for switching energy sources that are currently under development; | By 2040 |
| Adjustments in train schedules and pricing to meet the needs of shippers | Within 5 years |
| Synchronize train movements between countries to reduce transit time and delays | Within 5 years |
| Simplification and digitalization of cargo and transport documents | Within 5 years |
| Improve efficiency of operations in consolidating shipments, transferring them between road and rail and distributing them to their final destination | Within 5 years |
| Logistics facilities that can process unit trains, serve as collection/distribution hubs and provide intermodal connections as reliable and flexible as direct road transport | Within 5 years |
Improve utilization of equipment by increasing the load factor, by reducing empty backhauls and reducing wagon turnaround time by faster loading and unloading

Expand use of audits, performance monitoring and IT systems to reduce fuel consumption and emissions through improved fleet management, locomotive operations, train control and track access.

Introduce more stringent emissions standards for heavy good vehicles.

Develop polices to transition to electric trucks and/or hydrogen fuel cells for long range trucking – when technology is sufficiently developed

<table>
<thead>
<tr>
<th><strong>4. Urban Air Quality and GHG Emissions</strong></th>
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<tbody>
<tr>
<td>The main sources of urban air pollutants in Nur-Sultan and Almaty are reportedly from power stations, boilers, construction and production sites, and motor vehicle emissions. The contribution of motor vehicles to urban air quality has not been modelled, so it is not possible to say the extent to which transport contributes to deteriorating urban air quality. However, motorization rates have been steadily increasing in Nur Sultan and Almaty since 2003, as shown in Figure 10, and are known to contribute to deteriorating air quality (see Figure 11). An important co-benefit of decarbonizing transport in urban areas, would be improved air quality and environmental health.</td>
</tr>
</tbody>
</table>

![Figure 10 – Trend in Registered Cars in Nur Sultan and Almaty (Thousands)](image)

![Figure 11 - Smog Layer over Almaty](image)

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19 IQAir
21 Source: Wikipedia.org
Based on air quality data\textsuperscript{22}, the percentage of pollutants from stationary sources in the cities of Nur-Sultan and Almaty is showing a downward trend, but emissions from mobile sources, ie vehicles, is increasing. For example, the share of emissions from vehicles in Nur Sultan in recent years\textsuperscript{23} is around 60 per cent and is expected to increase unless action is taken to reduce vehicle emissions. This is due to growth in vehicle numbers, as well as the use of older vehicles with poor emissions standards. A similar situation exists in other major cities in Kazakhstan.

Section 5 of this Annex, provides options that may be considered by Government to reduce emissions through the introduction of e-mobility; and Section 6.3 provides further initiatives that may be taken to promote modal shift in urban areas; both instrumental in reducing transport sector emissions in cities.

5. **Introducing E-Mobility**

Across Kazakhstan, motorization has been increasing (see Figure 12).

![Figure 12 - Motorization Trend in Kazakhstan\textsuperscript{24}](image)

Given that in 2019 it was estimated that only about 1,000 electric cars were in Kazakhstan of which approximately 200 were locally-produced\textsuperscript{25}, it follows that if current motorization rates are maintained, then in due course, almost the entire fleet will need to be converted to electric or alternative fuels, whilst phasing out the existing fleet. In terms of emission standards, EURO IV was introduced only in 2013.

5.1. **Policy Drivers for EV Adoption**

World Bank modelling shows that motorization will continue, due to increasing population and incomes, but partially offset by modal shift. However, based on lifetime investment and fuel costs, battery electric vehicles will become cost competitive with conventional vehicles by 2030 in Kazakhstan, and in the World Bank modelling dominate by 2040, both in the BAU and net zero scenarios (refer Figure 13). Overall numbers of cars is modelled as dropping, when comparing the BAU case with the NZE case, due to modal shift. For heavy goods vehicles, the modelling shows that electrification is delayed, reflecting the developing battery technology, but will dominate by 2050 (refer Figure 14).

\textsuperscript{22} IQAir

\textsuperscript{23} IQAir

\textsuperscript{24} Based on data from the Bureau of National Statistics, Republic of Kazakhstan. https://stat.gov.kz/

\textsuperscript{25} https://astanatimes.com/2019/07/kazakhstan-aims-to-increase-production-of-reduce-prices-for-locally-produced-electric-cars/
Based on information from the International Energy Agency (IEA)\textsuperscript{26}, strategies to promote the shift to emobility range from policy level reforms to operational incentives and recharging infrastructure. World Bank analysis\textsuperscript{27} shows that internationally, public support for charging infrastructure is more effective than consumer purchase subsidies in promoting EV adoption.

Fiscal incentives can spur the initial uptake of electric vehicles and underpin the scale up in EV manufacturing and battery industries. These incentives should focus on making EVs competitive and then gradually phasing out purchase subsidies as sales expand. The cost of ownership can be reduced through incentive measures such as free parking and free bus lane usage and/or through purchase subsidies, and/or vehicle purchase and registration tax rebates. Income tax discounts can also be applied. Differentiated taxation of vehicles and fuels, based on their environmental performance, and various regulatory measures, such as requiring mandatory targets for EV sales, can also be implemented as means to promote the clean vehicle industry. Economies such as Kazakhstan, with a large market for second-hand imported cars, can use policy levers to take advantage of electric car models at attractive prices.

Based on information from McKinsey \textsuperscript{28}, although consumers, in the short term, would incur higher upfront costs to buy low-emissions vehicles (depending on geography and vehicle type BEV is currently about 30 to 90 percent more than that of an ICE car), it is expected that the price gap will narrow over time as battery prices drop. But even with higher upfront costs, the McKinsey analysis suggests that internationally, whole-of-life cost to own an EV, will be cheaper than an ICE car from about 2025, assuming battery costs fall as expected. So promoting the whole-of-life ownership cost projections to the public, can help gain momentum for the shift to e-mobility.

\textsuperscript{26} IEA Report – Global EV Outlook, 2021
\textsuperscript{27} https://blogs.worldbank.org/transport/if-you-build-it-they-will-come-lessons-first-decade-electric-vehicles
\textsuperscript{28} McKinsey; The net-zero transition - What it would cost, what it could bring, Brussels January 2022.
Consideration can also be given to creating domestic production industries for electric vehicles and batteries. This would best be provided by the private sector, but could be supported through a range of tax incentives on materials extraction industries and battery production. This has not been studied in this report, but could form part of assessment studies moving forward.

A key issue for drivers is convenient and affordable publicly accessible chargers. Governments can support EV charging infrastructure through measures such as direct investment to install publicly accessible chargers or incentives for EV owners to install charging points at home. Some places may require modifications to include charging points, such as in apartment blocks and retail establishments, and again, incentives could be used to allow for the retro-fitting.

The private sector can also be incentivised to strategically deploy public charging infrastructure in public places, although it can be owned and operated by vehicle manufacturers, governments, municipalities or even electricity retailers, but a strategy for its roll-out needs to be adopted to ensure that at least one party deploys the infrastructure and that a viable business model for private sector deployment of public charging infrastructure be adopted. The optimal strategy, which has not been studied in this report, is unique for each mobility sector and each power system, and depends on various variables, including the flexibility of sources in the power system, grid capacity; and the composition of the sub-sectors (passenger cars, light-duty commercial vehicles, heavy-duty vehicles, buses, two- and three-wheelers).

Policy attention is also needed to broaden decarbonisation to commercial vehicles including trucks and buses. Progress in batteries has led to rapid commercialisation in the past few years, with more models in the heavy vehicle segments, but the market is still maturing. Decarbonisation measures in freight and logistics are reviewed in Section 7.

Electric buses are already being introduced in some Kazakhstan cities - refer to Section 6.1. But further policy measures and investments in rolling stock and infrastructure will promote uptake – eg, green public procurement programmes, purchase subsidies and direct support to charging infrastructure deployment, effective pollutant emissions standards; dedicated bus lanes to improve service standards, and the like. The modelling includes estimated costs to deploy more electric buses and forecasts some modal shift.

6. Clean and Sustainable Urban Transport

Kazakhstan is a large country, with an area equal to Western Europe, but with a total 2020 population of just under 19 million, it has one of the lowest population densities in the world. Populations in Almaty (~1.8 million), Nur-Sultan (~1.1 million) are expected to grow significantly by 2030 and to require significant investment in urban transport services and infrastructure. Action is needed now to avoid further lock-in to high emissions pathways.

COVID-19 affected severely the provision of public transport. COVID-19 containment policies included closures of public transport systems. In Kazakhstan, the overall passenger turnover in 2020 went down by

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30 https://www.worldbank.org/en/country/kazakhstan/overview#1
31 World Bank estimate, 2019
65% (vs. 2019). Anecdotal evidence suggests the disruptions and concern around safety may have accelerated a shift towards private vehicles.

In 2018, Almaty and its surrounding region\textsuperscript{32} accounted for almost 25% of all cars registered in Kazakhstan, with about half registered in the city. Roughly 12% of the national fleet is registered in Nur-Sultan, Kazakhstan’s political capital, and the surrounding Akmola oblast. As urban fleets expand, so do the share of aged vehicles, see Figure 15. Large numbers of used cars from Russia and Eastern Europe have been imported into Kazakhstan in the past, due to lower costs, straight-forward customs procedures and low taxation.\textsuperscript{33} Custom clearance fees for used vehicles in Kazakhstan tends to be only 1-2% above the 15% levied on new light-duty vehicles\textsuperscript{34}. And with populations and incomes forecasted to continue increasing, the demand for motor vehicles will continue to grow. Thus, managing motorization will be critical in any effort to decarbonize road transport.

\textbf{Figure 15 - Age of Private Vehicles in Kazakhstan, January 2021}\textsuperscript{35}

Increasing motorization of ICE vehicles, is driving congestion and local emissions. Almaty Akimat estimates that the equivalent of 150% of the cars registered in the city use its road network daily. TomTom\textsuperscript{36} data showed peak hour traffic speeds in April 2019 to be 50% slower than free flow speeds in the Almaty region, with traffic in the city being frequently at a standstill. Congestion raises transport’s contribution to local particulate emissions through the idle running of engines, fuel-inefficient driving patterns and the need to drive extended distances to secure parking spaces.

\begin{figure}
\centering
\includegraphics[width=\textwidth]{age_of_private_vehicles.png}
\caption{Age of Private Vehicles in Kazakhstan, January 2021}\textsuperscript{35}
\end{figure}

\textsuperscript{32} Almaty Oblast
\textsuperscript{33} No customs fees are applied to cars produced in CIS countries
\textsuperscript{34} https://kolesa.kz/content/articles/skolko-stoit-rastamozhit-legkovoj-avtomobil-v-2020-godu-v-rk/
\textsuperscript{35} Source: Statistics Agency of Kazakhstan
\textsuperscript{36} TomTom Traffic Index show how people move at the local and global levels. https://www.tomtom.com/en_gb/traffic-index/
Although in recent years there have been attempts to substitute buses with newer models running on cleaner fuels, traffic congestion and emissions nevertheless poses a risk to economic development and health. Urban freight traffic and inadequate public transport are significant issues in Almaty. The Central Asia Regional Economic Cooperation (CAREC) data suggests that the transport costs for road cargo in Kazakhstan are highest in Almaty region, owing to their route through the congested urban center. This is exacerbated by inadequate public transport services that have not kept pace with urban developments. As a response, the city has expressed its desire to implement various traffic management strategies that include redefining the road network hierarchy, prioritizing buses at traffic signals, implementing a smart traffic signal system, and diverting heavy goods vehicles from the city center during peak hours.

Government has shown interest in addressing emissions through alternative fuel programs. Kazakhstan’s national “Concept for the Transition of the Republic of Kazakhstan to the Green Economy” and Almaty’s “Sustainable Transport Strategy 2018-2026” aim to reduce air pollution by 32% below 2018 levels by 2025 by growing public transport’s share of total journeys and accelerating (i) the uptake of electric and other low emission vehicles and (ii) the deployment of infrastructure for alternative-fuel vehicles.

In late 2017, the “Digital Kazakhstan” state national program introduced a “smart city” concept with the goal of having city services and resources interact and collaborate with private initiatives to ensure a sustainable city development and to create favorable conditions for residents and visitors through the use of real-time information.

Kazakhstan government has committed to developing energy-efficient public transport. To advance toward that goal, in 2015 it started working with OECD to analyze how a public investment program could spur cleaner public transport to reduce air pollution and GHG emissions in large cities. It assessed that that the basic regulatory framework to advance clean public transport is in place, but it lags in the development of modern emission norms. The program’s focus is the shift toward clean buses and will work on two stages: a pilot in Kostanay and Shymkent, followed by a second phase across all major cities.

6.1. Urban Transport- Almaty

Conceived to cover the 2013-2023 timeframe, the city’s ambitious transport strategy set the goal of having a “high-quality, integrated, safe and sustainable service” from their transport system by 2023. It was developed to address multiple challenges, including congestion, environmental issues, social exclusion, unattractive public transport, and lack of integration between transport and urban planning. It set a number of key strategies, including to:

- Support public transport, walking and cycling as sustainable modes of transport in the city center,
- Reduce transport related air pollution,
- Improve public transport services,

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38 2021, Asian Development Bank, Kazakhstan: A Future Without Coal?
41 2018, OECD, Promoting Clean Urban Public Transportation and Green Investment in Kazakhstan. Green Finance and Investment
42 “City of Almaty Sustainable Transport Strategy”
Develop Almaty into a walking and cycling city,
Adjust the road network in accordance with the needs of the sustainable transport system, so that trucks and through-traffic will avoid passing through the city,
Actively manage traffic in the city center,
Introduce on-street parking management in the city center,
Better integrate urban planning with transport planning; and
Integrate Almaty’s transport system with the suburbs

By implementing these strategies, the City was aiming to:
Reduce air pollution emissions and GHGs by 32% relative to the then current levels
Increase the market share of sustainable transport modes (public transport, walking and cycling) from 42% currently, to 55%
Decrease the number of fatalities due to road accidents, especially accidents involving pedestrians, by 35%, and
Reduce congestion in the city center by 30%

Metro is only available in Almaty, with one line and nine stations and covers a limited city area, although expansion is planned. In addition there are 110 bus routes, operating with diesel, gas and electric. Also trolley-buses operate from an overhead catenary, connecting eight routes over 115km across the city and servicing 11% of transport demand. In 2019, a new publicly owned operator was established to pilot a ten-strong battery electric bus fleet servicing a linear 14km intra-urban route in Almaty. The Municipal Government has plans to expand the fleet to 40. In partnership with the EBRD, Almatyelectrotrans is exploring the potential of introducing 200 battery-powered (hybrid) trolleybuses to its fleet of electric vehicles.

Launched in 2015, ‘Smart Almaty’ is based on information and communication technologies to target issues in six priority areas. The city benchmarked its smart systems with transport being scored 1.37 on a scale of 5. To date, four of six initiatives under the “Smart Almaty” initiative target transport: (i) electronic ticketing, (ii) smart parking, (iii) bicycle sharing, and (iv) road safety. Plans included the use of cameras, GPS and sensors to optimize traffic, provide real-time information for users and divert trucks (transit traffic) from the city center, through the creation of a congestion charging scheme. We have no information as to the progress on implementation of these initiatives, and moving forward, this could be further investigated as a means to identify decarbonization options.

6.2. Urban Transport – Nur Sultan

Pressing transport-related issues hindering socio-economic development of Nur-Sultan are traffic congestion, and associated negative consequences of poor air quality. There is a growing need to increase capacity and improve public transport as about 55% of local air pollution is reported to be generated by the transport sector and particulate emissions are frequently at unsafe levels.

44 EBRD – European Bank for Reconstruction and Development
45 World Bank, Concept Note “Innovative Solutions for Urban Mobility in Central Asia”. P17590.
Currently, the main means of public transport in Nur Sultan is by bus, which reportedly includes some 100 electric buses. In 2020, the bus network carried about 712,000 passengers per day. Since 2015, the city authorities introduced some solutions to increase bus public transport usage - new buses were purchased, dedicated bus-lanes were allocated, warm bus stops constructed, and a mobile application for tracking buses was launched, amongst other initiatives.

These initiatives have proved to be positive. As part of the “United for Smart Sustainable Cities” (U4SSC) initiative, the United Nations Economic Commission for Europe (UNECE) evaluated the city against the Key Performance Indicators for Smart Sustainable Cities. The length and convenience of the public transport network was rated as high, with 69% of the population living within 500 meters of a transit stop and 95% of stops displaying dynamic information. But indicators related to shared bicycles and vehicles, presence of low-carbon passenger vehicles, and the length of the bicycle network were rated low.

6.3. Strategies to Decarbonize Urban Transport

Kazakhstan cities may focus on prioritizing strategies that encourage synergies which are more likely to advance other goals while simultaneously decarbonizing transport emissions. Various strategies that serve to promote a shift to lower and zero emission mobility systems can also result in additional benefits, such as enhanced access, accessibility, health improvements and equity.

Such strategies can be broadly grouped into:

- **Land use**: Enacting more efficient land use regulations to promote compactness and mixed-uses and encouraging high-density and transit-oriented developments (TOD).
- **Active travel (walking and bicycling) modes**: Providing high-quality, dedicated, physically protected, connected networks; prioritizing public space for vulnerable users through complete streets; implementing bike-sharing systems; and promoting e-bikes.
- **Public transportation**: Providing dedicated, connected, and frequent-service bus networks; working to modernize informal transportation; developing/expanding rapid transit networks (metro, rail, and bus rapid transit); and improving service through operational reorganizations and fleets renewal.
- **Private vehicle controls**: Implementing motorization management strategies to improve control of the age, safety, and emissions standards of private vehicles; and developing travel demand management (TDM) policies to better align the convenience and cost of both driving and parking with their negative externalities by pricing parking, pricing emissions, and/or pricing congestion, and also to nudge people toward more sustainable travel modes and behaviors with technological and informational instruments.

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47 https://alrt.kz/news/319
48 2020, United Nations Economic Commission for Europe, Smart Sustainable Cities Profile, Nur-Sultan, Kazakhstan
49 2021, World Bank, Transport Decarbonization Investment Series, “Decarbonizing cities by improving public transport and managing land use and traffic”
50 2021, Institute for Transportation and Development Policy and University of California, Davis, “The Compact City Scenario – Electrified. The only way to 1.5°C”
The people-centered **Avoid-Shift-Improve (ASI)** approach can help to prioritize the actions required to reduce the environmental impact of urban transportation in Kazakhstan cities. The ASI approach entails three pillars.\(^52\):

- **Avoid/Reduce** refers to the need to improve the efficiency of the entire transport system. By pursuing transport-oriented, compact development of cities, and transportation demand management, the goal is to reduce the need for motorized travel as well as trips lengths.
- **Shift/Maintain** seeks to improve the efficiency of individual trips. The goal is to shift trips from highly energy consuming and polluting modes, such as private vehicles, toward the more environmentally friendly modes: public transport, bicycling and walking.
- **Improve** focuses on vehicle and fuel efficiency, use of renewable energy sources, and public transport operational efficiency.

The "avoid" approach requires a big effort to drive system-level change but has a large potential for emission cuts. In urban areas, for example, they can reduce unnecessary transport through sustainable urban design, such as transit-oriented design, compact cities and/or mixed-use development. “Shift” refers to modal shifts to more sustainable options, including from cars to public transport, cycling and walking. “Improve” refers to the efficiency improvement of fuels and vehicles, including emobility.\(^53\)

For the ASI framework to achieve its intended results, it is key to develop a balanced and comprehensive strategy that combines incentives (“pull” actions) for the use of cleaner and more active travel modes, with (“push”) actions that help decrease the inefficient use of low-occupancy private vehicles.

If cities focus only on providing pull actions (such as those to improve transit systems and to incentivize active travel) without addressing the subsidized low cost and convenience of driving and parking in urban areas, the resulting mode shift, and the consequent emissions reductions, will likely be modest. Improving public and active transportation and land-use regulations, combined with the implementation of transport demand management schemes, can achieve more sustainable results than mobility-enhancing strategies only.\(^54\) \(^55\)

General actions that may be considered for all cities in Kazakhstan may include the strategies in Figure 16.

| **Integrate transportation and land use decisions, encouraging compact and mixed-use developments within existing urban areas, discouraging dispersed, auto-dependent developments at the city fringe** |
| **Enact/update development regulations and norms to promote attractive, efficient, and livable communities, improving accessibility and reducing private vehicle travel** |
| **Increase the scope of sustainable public transport options, and the low emission fleet, including proposed plans to expand the Almaty Metro system** |

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\(^52\) Transformative Urban Mobility Initiative (TUMI), Implementing the New Urban Agenda # 9, ASI. Retrieved from: [https://www.transformative-mobility.org/publications/inua-9-avoid-shift-improve](https://www.transformative-mobility.org/publications/inua-9-avoid-shift-improve)


\(^55\) 2021, World Bank, Transport Decarbonization Investment Series, “Decarbonizing cities by improving public transport and managing land use and traffic”
<table>
<thead>
<tr>
<th>Road diets and traffic calming schemes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Segregated, high-quality infrastructure for pedestrians and bicycle users</td>
</tr>
<tr>
<td>Reallocate public spaces to prioritize active travel modes</td>
</tr>
<tr>
<td>Incentivize micromobility schemes (scooters, bike-sharing, e-bikes)</td>
</tr>
<tr>
<td>Car Free Days</td>
</tr>
<tr>
<td>Incentivize bicycle parking in high-use buildings</td>
</tr>
<tr>
<td>Network of dedicated bus-only lanes to reduce travel times and increase service predictability</td>
</tr>
<tr>
<td>Universal access in all new infrastructure, rolling-stock &amp; retrofit non-compliances.</td>
</tr>
<tr>
<td>Revise public transportation routes, frequencies, fare policies, and customer information to reflect citizens input and priorities and improve the quality of service</td>
</tr>
<tr>
<td>Increase safety for vulnerable users (pedestrian crossings, school zones, bike lanes, bus stops, etc.)</td>
</tr>
<tr>
<td>Continuous training for bus drivers - focus on customer service and safe driving</td>
</tr>
<tr>
<td>High-impact public information campaigns to promote environmental, health and economic of using sustainable travel modes (public transport, bicycle, walking)</td>
</tr>
<tr>
<td>Incentive programs for city employees to use sustainable travel modes for commuting; eg PT, carsharing</td>
</tr>
<tr>
<td>Re-consider urban parking – charges, restrictions, enforcement</td>
</tr>
<tr>
<td>Reduce/remove fossil-fuel subsidies</td>
</tr>
<tr>
<td>Consider congestion-charging and create low emission zones in dense city areas</td>
</tr>
<tr>
<td>High-occupancy lanes including use by low-emissions vehicles</td>
</tr>
<tr>
<td>Integrated park and ride hubs</td>
</tr>
<tr>
<td>Fiscal and tax incentives for improved uptake of low emission vehicles.</td>
</tr>
<tr>
<td>ITS and smart traffic control schemes</td>
</tr>
<tr>
<td>Real-time bus information systems</td>
</tr>
<tr>
<td>Traffic signal operating plans to prioritize pedestrians, cyclists and buses at critical intersections</td>
</tr>
<tr>
<td>Renew old, polluting vehicles by creating scrapping programs</td>
</tr>
<tr>
<td>Purchase zero or low-emission official vehicles</td>
</tr>
<tr>
<td>Ensure availability of charging infrastructure for electric vehicles in public spaces &amp; subsidy schemes to upgrade charging infrastructure in homes and apartments.</td>
</tr>
<tr>
<td>Implement emissions-based vehicle charging schemes</td>
</tr>
<tr>
<td>More stringent vehicle fuel standards</td>
</tr>
<tr>
<td>More stringent vehicle emissions standards.</td>
</tr>
</tbody>
</table>

7. Reducing Emissions in Freight Transport

There are various strategies that can be used to reduce the amount of energy consumed, and the associated emissions of greenhouse gas from the transport of freight. These include - is to encourage a shift in the mode used to transport cargo domestically, internationally, and in transit; and reducing direct emissions in the two main modes (rail and road) through technology based improvements, and by improving operational efficiencies.

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56 A road diet is “generally described as reducing the number of travel lanes and/or narrowing travel lanes in a roadway to utilize the space for other uses and travel modes. This is one strong option for consideration in building BRTs. By narrowing marked lanes, lower speeds can be achieved, which creates a more comfortable environment for all road users including pedestrians and cyclists.” Source: Job, RFS. & Mbugua, LW. (2020). Road Crash Trauma, Climate Change, Pollution and the Total Costs of Speed: Six graphs that tell the story. GRSF Note 2020.1. Washington DC: Global Road Safety Facility, World Bank.
7.1. Modal Shift Opportunities

**Competition Between Modes**

The principal competition for Kazakhstan’s domestic, international and transit cargo is between rail and road. Air freight is not a significant competitor because of the much higher cost. Competition from ocean shipping for international and transit cargo is limited since Kazakhstan is landlocked, although some freight from China, which currently goes by rail through Kazakhstan, may revert to maritime shipping if the northern corridor remains constrained due to the sanctions on Russia.

With regards to competition between road and rail, there is a general assumption that road transport is less costly for distances under 750-1000 km, however, in the case of Central Asia the breakeven distance is generally set higher. In fact, the choice between modes involves a much more complex relationship based on the characteristics of the cargo, the markets served and the supply chain that connects the source and final destinations. The primary factors affecting modal choice are shown in Table 3.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Description</th>
<th>Modal Share Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct Cost</td>
<td>An important aspect of the lowest shipping cost for a particular logistics chain, is handling costs, i.e. for loading/unloading cargo, which depends on size and type of cargo. Bulk cargoes generally have a lower handling cost; breakbulk cargo a higher cost; with unitized cargo usually somewhere in between.</td>
<td>As a result, railroads have a significantly lower unit handling costs for large quantities of bulk cargo while trucks have an advantage for smaller quantities of breakbulk cargo.</td>
</tr>
<tr>
<td>Load Factor</td>
<td>Load factor varies with travel direction. It’s common to have an empty load when returning, with a shipper paying full round-trip cost. This occurs when special equipment is needed, and for containerized cargo which returns empty or partially so.</td>
<td>Trucks have an advantage to more easily arrange triangular routes to backhaul cargo or for cabotage cargo on the return journey based on registration nationality.</td>
</tr>
<tr>
<td>Time</td>
<td>Time is important for higher-value goods because of the carrying cost of the goods. It is also important for shipments that require shorter order cycles, in order to respond to fluctuations in demand.</td>
<td>Transit times for trains and trucks are often similar with trains compensating for a lower speed with 24 hour/day operation. But the time for mobilization, loading, unloading and demobilization is generally less for trucks than train</td>
</tr>
<tr>
<td>Reliability</td>
<td>Generally measured as the quantity ordered and delivered in good condition at the agreed time. Traditionally, the principal impact of reliability has been on the amount of inventory required to avoid shortages. But the introduction of lean production has required synchronized delivery of various inputs, placing a premium on reliability.</td>
<td>Road transport often has a significant advantage.</td>
</tr>
</tbody>
</table>

---

57 The rates per ton-km for the different modes vary by distance and size of shipment and more recently by shortages in capacity. A rough approximation of the ratio between ton-km rates for ocean:rail:road:air is 1:2:3:30 although ocean rates are currently comparable or sometimes greater than rail rates.
Flexibility

Is important where there is volatility in either the volumes shipped or the origins and destinations between which the goods are shipped.

Road transport has an advantage – flexibility to route cargo and to respond to volume fluctuations.

Cluster Density

Geographic distribution of the source of the goods and delivery destinations. A train has a capacity of between 50-100+ trucks, so it’s more efficient for shipments sourced from, and received at, a single location, where both have direct access to a railyard. If cargo originates at several locations within a production cluster and/or is destined for several locations within a consumption cluster, trucks are needed at both ends to complete the journey.

The result is competition between road and intermodal transport in which door-to-door movement by road may have an advantage in terms of time and cost but also reliability.

Specific Factors Affecting Kazakhstan Modal Share

Typically, rail is used to transport large shipments of low-value products over longer distances while road is used for smaller shipments of higher value cargoes over shorter distances. This applies to most of Kazakhstan’s international, domestic and transit freight. Most of Kazakhstan’s exports are bulk commodities shipped to neighboring countries with the result that rail has a modal share of 90%. In contrast, imports are higher-value, general cargo such as machinery and consumer goods for which rail has only about a 50% share. For domestic shipments, rail is used to transport large shipments of bulk cargoes such as coal and petroleum over longer distance; but road is used for smaller shipments and shorter distances. Non-bulk cargoes are transported almost exclusively by road, primarily for distances of less than 100 km. The modal split between road and rail modes is shown in Figure 17.

Emissions Intensity – A Comparison Between Transport Modes

Based on work done for the European Environment Agency, a study comparing the GHG efficiency rates of passenger and freight modes was conducted in 2020 (see Table 4). This study was based on ‘well-to-wheel’ emissions, meaning that emissions from the production and distribution of fuels are accounted for. The values are therefore not strictly representative of Kazakhstan, given the different GHG intensity of energy production and geography. But the work is useful to broadly demonstrate the relative emissions efficiencies between freight modes.

<table>
<thead>
<tr>
<th>Mode</th>
<th>gCO2 emitted per t.km</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Cargo</td>
<td>1,036</td>
</tr>
<tr>
<td>Heavy Goods Vehicle</td>
<td>137</td>
</tr>
<tr>
<td>IWW Transport</td>
<td>33</td>
</tr>
<tr>
<td>Rail Freight</td>
<td>24</td>
</tr>
<tr>
<td>Maritime Shipping</td>
<td>7</td>
</tr>
</tbody>
</table>

58 This is high by international standards, but is declining
Emissions for freight transported by maritime shipping, rail and inland waterway are very low compared with those for freight transported by heavy goods vehicle, inferring that increasing the modal share of freight transported by rail and river, in comparison to freight by heavy goods vehicles, offers an opportunity to help decarbonize the transport sector. Figure 17 shows the modal split between road and rail (the two dominant freight transport modes in Kazakhstan). It also shows how the volume of freight (in ton.km) has gained modal share over the period 2003 to 2018.

To illustrate further, applying some standard emissions factors\(^61\) to the freight volumes in Figure 17, would result in the following estimated emissions. This example shows that although freight (in terms of Mt.km) moved by truck in 2018- is about 40% of the total of that moved by rail and road together, that emissions from road trucks contributes almost 80% of the emissions of the combined total.

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\(^60\) Based on data from the Bureau of National Statistics, Republic of Kazakhstan. https://stat.gov.kz/

**Options to Promote modal Shift**

It is not feasible to shift all road freight to rail, and the scope of this shift must be considered against the evolution of regional trade. While there has been significant improvements in the quality of service provided by KTZ, overall modal share by rail has not increased. In the case of domestic shipments, the railroad transports a significant quantity of bulk cargo for a few customers, while most of the cargo is transported by road. For international shipments, most exports are bulk cargoes moved by rail while the majority of imports are medium-high value goods shipped by road. For transit cargoes, rail has successfully captured almost all of the containerized consumer goods exported from Western China. Shipments via Kazakhstan to Russia, Belarus and Central Asia are transported primarily by road. It should be noted that rail also transports coal and oil products, and this is explored further in Section 8.

KTZ’s modal share is consistent with experience elsewhere. It has a dominant share for large shipments of bulk cargoes travelling lengthy distances, whereas road transport has a dominant share for smaller shipments of semi-bulk and general cargo moving shorter distances. The overall modal share for international shipments is high compared to other countries but consistent with the extensive use of rail transport in the countries of the former Soviet Union.

Most of future competition between road and rail will likely need to focus on the movement of small-to-moderate size shipments of semi-bulk and unitized cargo. These will require additional improvements in the availability and quality of rail services. Some improvements have already been achieved through:

- Adjustments in train schedules and pricing to meet the needs of shippers,
- Synchronization of train movements between countries to reduce transit time and delays,
- Simplification and digitalization of cargo and transport documents and
- Provision of complementary logistics services.

In order to compete for medium to small shipments, the quality of rail service and the performance of door-to-door supply chains, would need to improve. Therefore, an important strategy for increasing rail modal share is to improve the logistics services embedded in the shipper’s supply chains, specifically:

- the efficiency of operations in consolidating shipments, transferring them between road and rail and distributing them to their final destination and
- the marketing of rail services as part of an integrated supply chain, and
- provision of scheduled trains that match the shipping schedule of cargo owners.

This will require an increase in the participation of private third-party logistics (3PL), providers who consolidate smaller shipments and sell wagon loads on scheduled unit trains.

### 7.2. Improve Operational Efficiencies

Modal shift may be induced, and emissions reduced, by transporting freight by rail more efficiently. One of the biggest constraints to efficiency is the lack of backhaul cargoes for bulk rail shipments. In general, this is due to the type of wagons required for handling specific commodities, but it is also caused by imbalance between large consignments of low-value cargo, in the primary direction and smaller consignments of higher-value unitized cargo in the other direction. There is a similar problem for container shipments due to not only the imbalance of flows but also the challenge of repositioning containers to specific locations in order to reload cargo as quickly as possible rather than waiting for return cargo.
KTZ has attempted to address this and to prioritize the provision of logistics services related to rail transport through decentralization (see Table 5) and through collaborations with rail service providers, e.g. UTLC\textsuperscript{62}. In addition, it has allowed two private companies to provide specialized services for domestic shipments of coal and petroleum. A further step would be to increase the opportunities for 3PL providers to participate in the marketing and arrangement of rail shipments, both multiple wagons and unit trains. This is important since railroad organizations ultimately focus on the use of rail assets whereas 3PLs focus on supply chains.

<table>
<thead>
<tr>
<th>Table 5 - KTZ's Logistics Subsidiaries</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Kaztransservice owns and manages KTZ’s container fleet and serves as a container “operator” merged into UTLC, a joint venture with TransContainer and Belarus Railway Logistics services</td>
</tr>
<tr>
<td>• Kaztemirtrans owns and manages about 55,000 freight wagons and determines customer prices for services rendered. It also has workshops and depots for wagon repair, and is responsible for financing new wagons.</td>
</tr>
<tr>
<td>• KTZ Express provides logistics services utilizing KTZ logistics assets including airport terminals, international trade zones and warehousing facilities</td>
</tr>
<tr>
<td>• Kedentransservice operates a total of 17 terminals throughout Kazakhstan, including Dostyk and the container transfer facilities at Altynkol Station at the Chinese border ((Khorgos)</td>
</tr>
</tbody>
</table>

Other opportunities to improve efficiency and thereby reduce GHG emissions, include:

o Improving the utilization of equipment. The most significant improvements involve increasing the load factor, especially through a reduction in empty backhauls (as mentioned above), but also by reducing the turnaround time for wagons through faster loading and unloading.

o International experience shows that railways can take incremental steps in the improvement of energy efficiency that compound and achieve significant savings. For example, wheel lubrication, idling shut off, employee incentives for optimal braking and acceleration, and optimal train loading, are just a few of the many options that railways can implement at relatively low cost, to achieve marginal improvements. However, when these gains are combined and sustainable, they have demonstrated to accrue significant fuel efficiency and emissions reduction. This also improves the competitive position of the railway against the road sector and can potentially increase gains even more as freight is shifted from trucks.

o Develop logistics facilities that can process unit trains, serve as collection and distribution hubs and provide intermodal connections as reliable and flexible as those of direct road transport.

o Expand use of audits and performance monitoring to reduce fuel consumption and emissions and IT systems to improve fleet management, locomotive operations, train control and track access.

7.3. Reducing Direct Emissions

Rail Infrastructure

Kazakhstan’s rail network is about 16,000 km in length. About 4,900 km is double-tracked and 4,216 km\textsuperscript{63} is electrified. Opportunities for extension of the rail network, double tracking and electrification are long-

\textsuperscript{62} Joint stock company “United Transport and Logistics Company – Eurasian Rail Alliance” (JSC UTLC ERA), Transport services for containers by regular container block trains on the route China-Europe-China through Kazakhstan.

\textsuperscript{63} “Railway Sector Assessment for Republic of Kazakhstan, March 2021; CAREC.”
term strategies constrained by financing to high-density corridors, many of which have already been improved. However, there are plans for further electrification (as shown in Figure 19).

**Figure 19 - Plans for Electrification of Rail**

![Figure 19 - Plans for Electrification of Rail](image)

<table>
<thead>
<tr>
<th>Name</th>
<th>Distance, km</th>
<th>Implementation period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modernization and electrification of the Dostyk - Molymy railway line</td>
<td>883</td>
<td>2021-2025</td>
</tr>
<tr>
<td>Construction of the Darbaza – Mastaqal railway line</td>
<td>106</td>
<td>2022-2024</td>
</tr>
<tr>
<td>Construction of the Almaty bypass railway line</td>
<td>73</td>
<td>2022-2023</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>1,012</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Rail Network Fleet**

For the rail network, the introduction of more energy-efficient technologies in terms of infrastructure and rolling stock may present significant challenges.

KTZ uses both diesel and electric locomotives for its freight operations. The number of units has not changed significantly over the last five years as shown in the Table 6. About 56% of the locomotives have been in service for more than 25 years. A large percentage have been overhauled and new equipment introduced through a long-term agreement with GE/Wabtec for local production. This latter includes the twenty EVOLUTION locomotives recently acquired by KTZ.

**Table 6 - Railroad Freight Rolling Stock**

<table>
<thead>
<tr>
<th>Units</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locomotives (Total)</td>
<td>1,725</td>
<td>1,732</td>
<td>1,714</td>
<td>1,722</td>
<td>1,733</td>
</tr>
<tr>
<td>electric</td>
<td>539</td>
<td>549</td>
<td>546</td>
<td>549</td>
<td>548</td>
</tr>
<tr>
<td>diesel</td>
<td>1,186</td>
<td>1,183</td>
<td>1,168</td>
<td>1,173</td>
<td>1,185</td>
</tr>
</tbody>
</table>

The replacement of older equipment with more energy-efficient models is an obvious strategy. However, locomotives that utilize new power sources are still in the research stage. Perhaps the most promising is hybrid locomotives. These add battery storage and regenerative braking to the diesel-electric locomotive. The regenerative braking is most beneficial when operating in hilly areas. These locomotives are still in

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64 From a presentation by the Deputy Chairman of the Board of JSC KTZ, at the Caspian Ports Conference in October 2021.
65 Diesel locomotives built by GE Transportation Systems (now Wabtec), initially designed to meet US EPA locomotive emissions standards.
66 Data from the Bureau of National Statistics.
the early stage of development but progress in increasing the energy density of batteries should shorten the time when these will be available for commercial operation.

Another option is to increase the ratio of gross-to-tare weight for wagons. This is especially important for transport of containers since the gross weight of an FEU\(^\text{67}\) is typically 20 tons which is similar to the tare weight of the wagons used to transport the container. A few countries have succeeded in doing this by allowing heavier axle loads. Currently, this is not a realistic option, not only because of the cost, but also because it would have to be applied to the entire region. A second approach is to replace older heavier wagons with lighter wagons of aluminium or metal composites. Unfortunately, these are not widely available and are more costly.

A third, and more common strategy is to introduce double stacking through the acquisition of well wagons. However, this is not possible on the electrified lines since the catenaries in Kazakhstan require 6.5m clearance above the rail. Also, some of the bridges and tunnels do not have sufficient clearance and the cost of modification may be difficult to justify given projected volumes. Finally, these cannot be used on the transit routes to Europe due to limits on both clearance and train weight.

**Energy Information Systems**

Another important mechanism for reducing fuel consumption and GHG emissions is to use information systems to improve operational efficiency. KTZ already has a reporting system for monitoring energy use. This has helped to document the decrease in annual fuel consumption and emissions. New, increasingly sophisticated, systems have been developed to monitor energy consumption for locomotives both when idling and underway. This information can be used not only to improve operator performance but also monitor the performance of individual locomotives. The latter information is necessary to inform preventive maintenance schedules and strategies for renewal and upgrade of locomotives. Other systems are used to optimize fleet management through reduction in the movement of empty wagons and repositioning of locomotives and wagons.

**Road Freight**

A regulatory environment that prices transport according to "polluter pays" principles is critical to provide economic equality for all modes of transport and to help unlock sustainability benefits of rail. However, as rail is currently mainly only competitive for longer distances and in view of other factors as described in Section 7.1, this limits the opportunities for modal shift, and so other opportunities for decarbonizing domestic freight, will be improvements in the emission standards of trucks and a transition away from internal combustion engines, when the technology is more available.

The modelling conducted by World Bank is premised on a shift to electric trucks, although the technology is still developing. Also, as hydrogen fuel cell technology develops, it may become more prominent in trucks with high range requirements, but this is not reflected in the modelling.

In the meantime, introducing higher emissions standards for domestic trucks and polluter pay principles, will help to reduce emissions, until the technology becomes cost competitive. The EU requires that foreign

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\(^{67}\) FEU - Forty-Foot-Equivalent-Unit, or the size of a 40ft standard shipping container
trucks entering the EU meet the Euro-5 standard. The Eurasian Economic Union has a similar requirement. The Kazakhstan truck fleet includes Euro 5 and Euro 6 vehicles for international shipment but about half of that fleet are Euro-4 or less (refer Table 7). Efforts to accelerate the replacement of older trucks with Euro-5 and Euro 6 trucks will not only reduce energy consumption and GHG emissions for domestic transport but also allow Kazakhstan to improve its ability to compete for international traffic.

<table>
<thead>
<tr>
<th>Euro Class</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>2.9%</td>
<td>2.0%</td>
<td>1.8%</td>
<td>1.5%</td>
<td>1.8%</td>
<td>1.9%</td>
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<tr>
<td>1</td>
<td>1.6%</td>
<td>1.6%</td>
<td>1.1%</td>
<td>1.1%</td>
<td>0.9%</td>
<td>1.2%</td>
</tr>
<tr>
<td>2</td>
<td>21.0%</td>
<td>20.3%</td>
<td>18.7%</td>
<td>15.3%</td>
<td>16.7%</td>
<td>15.0%</td>
</tr>
<tr>
<td>3</td>
<td>20.5%</td>
<td>19.8%</td>
<td>18.8%</td>
<td>22.9%</td>
<td>18.8%</td>
<td>19.7%</td>
</tr>
<tr>
<td>4</td>
<td>11.2%</td>
<td>10.9%</td>
<td>10.9%</td>
<td>11.4%</td>
<td>10.2%</td>
<td>11.2%</td>
</tr>
<tr>
<td>5</td>
<td>43.0%</td>
<td>45.4%</td>
<td>48.7%</td>
<td>45.8%</td>
<td>48.8%</td>
<td>48.0%</td>
</tr>
<tr>
<td>6</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>1.9%</td>
<td>2.8%</td>
<td>3.0%</td>
</tr>
<tr>
<td>Total fleet</td>
<td>7176</td>
<td>7320</td>
<td>7615</td>
<td>7001</td>
<td>7047</td>
<td>7613</td>
</tr>
</tbody>
</table>

8. Coal and Oil Transport

Two major commodities produced in Kazakhstan for both domestic consumption and export are coal and petroleum. The production of coal in Kazakhstan increased steadily over the last two decades but has levelled off in recent years (Figure 20).

In 2021 KTZ transported 106 million tons of coal, 3% more than in 2020. Domestic transportation of coal amounted for 74 million tons. The remainder was export, mainly to Uzbekistan, Turkey, Poland and Morocco. The main mining locations are Pavlodar region, Karaganda region and the East Kazakhstan region.

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68 World Bank calculations based on KazATO data, and excludes truck solely engaged on domestic routes
Rail is the dominant mode of transport when it comes to the initial leg of coal transportation. Coal transportation between the mines and power stations as well as manufacturing facilities is conducted on rail. However, there are also significant volumes of coal transportation delivered by road for smaller shipments from mines to the cities within a radius of 500 km of the mines. The principal destinations are municipal enterprises. There are also some shipments of coal on the road between the mines and producers of the enriched coal. In the peak seasons, KTZ lacks sufficient capacity of rolling stock suitable for transportation of coal. Waiting time to get the rail wagons for the unloading can reach two weeks and many producers divert shipments to road transport.

However, in Kazakhstan, the growth in exports of energy-related bulk cargoes is expected to level off in the future and then decline along with international demand for coal.

The volume of crude oil produced in Kazakhstan has increased steadily over the last two decades but at a decreasing rate. The annual production in 2021 was 85.7 million tons of which about 80% was exported. Most of this was transported by pipeline with a relatively small proportion by rail. The remaining 17 million tons were refined producing 13.1 million tons of refined oil and oil products of which 72% was gasoline and diesel fuel. For larger shipments, e.g. to power plants and large factories, the products were shipped by rail directly from the refineries. However, most oil products were distributed by tanker trucks.

9. Resilience and Adaptation

9.1. Hazards Impacting Transport Connectivity

Transport infrastructure and logistics networks in Kazakhstan are exposed to physical climate risks, in addition to the effects of the net-zero transition. With reference to Error! Reference source not found., the Climate Risk Index (CRI) ranks Kazakhstan as 144, where countries have been ranked from 1 to 181, with a score of 181 being at the lowest risk.

Although the CRI score for Kazakhstan is less than in many countries, the region faces a range of climate change induced hazards and risks, that will impact its transport systems and the global value chains that depend on that connectivity. The transport sector, in part because of its linearity, is and will continue to be particularly vulnerable to the impacts of climate change and other disaster risks. Disruptions to transport connectivity can have widespread adverse social and economic impacts. It also disrupts connectivity between cities and regions affecting global value chains and trade patterns, causing economic losses, and slowing down recovery and reconstruction efforts. Kazakhstan is expected to experience increasingly significant and frequent events attributable to climate change, such as droughts and desertification, windstorms, and flooding. Moreover, water levels in the Caspian Sea appear to be dropping, impacting port facilities. Such risks should be mitigated and managed through a combination of solid evidence-based planning, vulnerability assessments, design and engineering solutions, information technology for early detection, forecast, response, adequate allocation of financial resources, and enabling institutional foundations. The vulnerability of transport infrastructure to physical climate change and the sector’s importance to the broader economy necessitates integrating climate risk into planning for new and upgraded infrastructure. Analysis suggests that about 10% of Kazakhstan’s transport

70 Germanwatch – Global Climate Risk Index 2019
infrastructure is exposed to natural hazards, particularly flooding. The additional cost to firms from lower utilization of transport infrastructure due to natural hazards in 2019 was USD $1.1bn or 0.51% of GDP71.

9.2. Future Research to Evaluate the Resilience of Freight Corridors

Analysis to consider the impact on the flow of cargo from threats to the integrity and performance of the main transport corridors, could be conducted (but has not been done for this report). The impacts could be classified in terms of their scale and duration as follows:

- Short or long-term degradation in performance or capacity of specific links on the freight network
- Short-term or long-term disruption of service on specific links
- Permanent loss of specific links

Impacts would be those assumed to cause a disruption in service of sufficient length to require a rerouting of cargo or an alternative route. This would require an assessment of how those changes would affect not only the flow of trade but also the logistics used to integrate cargo movements and the supply chains used to deliver the commodities to the market. Typically, the analysis of the redistribution of cargo could be performed using a network model that reroutes cargo based on changes in the time and cost for transport of cargo on the individual links. However, this approach does not consider how logistics activities other than transport affect the routing nor does it consider how supply chains would be altered to minimize the impact of changes in the time and cost for transport.

One option for such an analysis might include:-

1. An examination of the operational capacity of the national freight network. To identify alternative routes that could be utilized in the event that transport on an existing route is disrupted.
2. An analysis of the current traffic on the network. This would include the rail density in terms of average trains per day on individual links and the volume of freight in terms of tons per commodity. The focus of this study would include the shipments between Kazakhstan, Russia, China and Central Asia. There is primarily bulk commodities transported by rail between Kazakhstan and Russia plus a smaller but increasing volume of road and rail traffic to and from Central Asia, primarily Uzbekistan. In addition, there are shipments that utilize a portion of the North-South Corridor, most notably containers moving on unit trains between China and Europe and domestic freight moving between Almaty and Shymkent and Karaganda.
3. An examination of opportunities and impacts for transferring freight from one mode to another in order to reroute cargo. This is of particular interest given the relatively high utilization of the rail network and much lower utilization of the road network. This examination would require an assessment of the logistics involved in transporting specific types of cargo. This would include the opportunities for modal substitution.
4. Examine the structure of the supply chains for the major commodities transported on Kazakhstan’s freight network. This analysis would focus not only on efforts to improve resilience to the impacts of climate change on the cost/time/reliability of transport services but also the opportunity to develop new supply chains.
5. The model could be further assessed with an understanding of the probability of hazards and vulnerability of each transport link.

71 Hallegatte, Rentschler and Rozenberg (2019), Lifelines, World Bank