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Study and
Recommendation for
Application of E-Mobility
in Mongolia

E-Mobility Roadmap

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Executive Summary

E-mobility readiness in Mongolia

Mongolia presents a unique context for e-mobility adoption. The country experiences extremely cold winters, has exceptionally low population density (outside of Ulaanbaatar), and the lowest cost (to user) and most carbon-intensive electricity in Asia. These all affect the technical, economic and policy case for electric vehicle (EV) deployment.

The E-Mobility Readiness Assessment provided rigorous analysis of EV suitability in Mongolia, alongside multi-criteria assessment of each major vehicle segment. None of Mongolia's unique challenges were found to be technology 'show-stoppers'. However, they do affect the techno-economic readiness of individual segments and their ability to support decarbonisation and other policy goals.

Almost two thirds (63%)¹ of Mongolia's vehicle fleet are automobiles. As in most developing countries, Mongolia's mass automobile market is highly capital cost sensitive, focused on used imports (most over 10 years old). High Internal Combustion Engine (ICE) vehicle vs EV upfront cost differentials, and low international EV equivalent supply, are therefore critical barriers to mass market EV uptake. This is exacerbated by Mongolia's acceptance of right-hand drive vehicles, favouring imports from Japan, where EV sales penetration remains the lowest among developed nations.

However, if these barriers can be overcome, the low cost of electricity (particularly in comparison to petrol prices) means the Total Cost of Ownership (TCO) of EVs across most vehicle segments was found to be comparable or better than that of their ICE counterparts. For instance, while an electric standard taxi is typically around 2.5 times more expensive to purchase than its ICE counterpart, the TCO of the standard electric taxi was found to be 25% less expensive than its ICE counterpart.

Study modelling found that reductions in Green House Gas (GHG) emissions and improvements in air quality as a result of EV adoption at the total vehicle stock level are relatively modest, but they are improvements nonetheless. At the total stock level, the reduction in GHG emissions as a result of EV adoption would be 2% by 2035, if EVs are proactively encouraged, compared to Business as Usual (BAU). However, for some segments, like light commercial vehicles and urban buses, this figure is higher. Particulate matter (PM) and Nitrous Oxide (NOx) emissions would also reduce by 7% and 10% respectively compared to BAU at the total stock level. However, Sulfur Oxide (SOx) emissions were found to not be substantially improved by EV adoption.

¹ National Statistics Office (2021)

Overall, the Readiness Assessment finds that EVs have limited market potential up to 2035, with only small-scale opportunities for policy-aligned public support in the following segments:

- **Private automobiles (mid range and new):** Newer vehicles, whilst a small market segment, have high commercial readiness, due to the relatively low differential in upfront costs between EVs and ICE vehicles in this segment. Steps taken now to enable their deployment (principally through charging infrastructure roll-out) will help prepare for mass EV transition in the long-term. Nevertheless, promoting private EVs should not be at the expense of other sustainable mobility initiatives, such as public transport.
- **Light commercial vehicles:** Urban taxis and light freight vans have a high market readiness, and can be supported by public policy as they support decarbonisation and contribute to urban air quality improvement. The key outstanding challenge is the lack of a suitable business model.
- **Urban buses:** These can support public policies to improve public transport and improve urban air quality when charged with renewable energy and as part of bus priority measures. With business model reform, e-buses can be implemented at a similar lifetime cost to the recent new EURO V diesel vehicles.

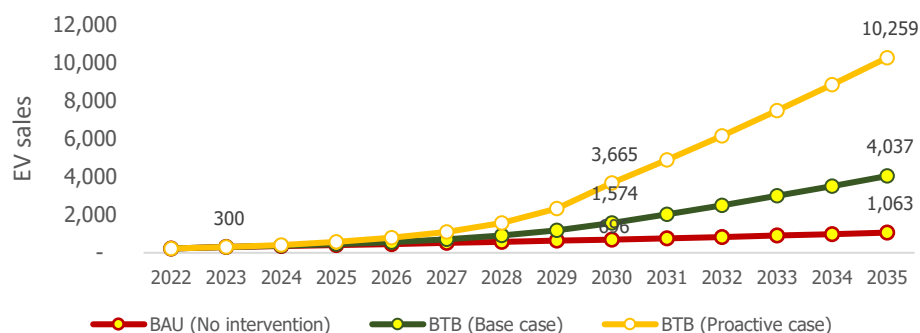
E-mobility scenarios for Mongolia to 2035

This E-Mobility Roadmap supports Mongolia to accelerate e-mobility adoption in a way that contributes to existing public policy objectives in the transport, environment, energy and urban management sectors. The approach taken by this study is to:

- **Enable market development of high readiness vehicle sectors** through regulatory and market coordination, particularly in the EV charging infrastructure field. A key focus is to enable private investment and unlock consumer demand for EV transition.
- **Proactively engage with targeted EV segments to catalyse demand,** using pathfinder projects and incentives to unblock bottlenecks in segments aligned with wider policy. These include battery electric buses (BEBs) in Ulaanbaatar, electric vans and urban taxis.

These segments have been modelled in two EV deployment scenarios (Base and Proactive), modelled against a 'No Intervention' baseline as shown in Figure ES-1 below. EV growth forecasts use analysis of Mongolian EV demand drivers (techno-economic) and EV penetration in Mongolia's key vehicle import markets (China, Japan and South Korea).

Figure ES-1: Forecast annual EV sales by scenario



Priority Roadmap Actions

The roadmap provides 31 recommendations to stimulate and shape EV growth, including both demand-side (prefixed D) and supply-side (prefixed S) policies. Priority actions include:

Enabling environment for private vehicles

The key objective here is to ensure that sufficient EV chargers are deployed and reliably available for users. Global experience is of EV charging as a private sector market (as for ICEV refuelling stations), for which the role of the public sector is to catalyse and shape a market for Charging Point Operators (CPOs) to roll out infrastructure. Key actions include:

Develop an EV charging planning framework and system, to identify needs for public and semi-public charging points and implement them using a concession model (see Recommendation S7). Within this, UBEDN should agree a clear decision-making framework for grid connections, provide information on available grid capacity, and expedite grid connections to CPOs with clear contact and protocols to enable delivery at pace (S8). The planning framework should enable citizens to suggest/request locations for public charging points (potentially through a web portal). Regulation is required to ensure that public charging spaces are only used by EVs being charged (D8) to maximise availability for EV users and to support the financial feasibility of the CPO business model.

Establish rights to EV charging in apartment buildings (D2): Most Ulaanbaatar residents live in apartment buildings. As in Norway, rights should be legally established for residents to install EV chargers within on-site parking lots, to support them to transition to EVs and to enable overnight EV charging to be prioritised (given its superior winter performance).

Implement a time-limited EV charger subsidy program (D7): In this early stage, a subsidy programme is advised to increase coverage of public charging and to promote best practice technologies to improve winter EV charging performance and manage grid demand impacts. Such a programme will enable promotion of public slow overnight charging (S2) and destination charging (e.g. at workplaces) as well as smart EV charging technologies (S5).

Implement targeted, low-cost financial incentives: Major subsidies are generally not appropriate for the Mongolian context. There may however be a case for equalising upfront taxes (in nominal terms) upon EV purchase/import with equivalent HEV/ICEV models (D10) and other small behavioural ‘nudges’² such as emissions-based parking fees.

Promote climate-appropriate EV technologies and user behaviours (S1): Experience from countries such as Norway and Canada shows that most winter performance issues can be mitigated. Mongolia should work with EV distributors to promote user behaviours and technologies to maximise winter performance. This includes the practice of battery pre-heating, the use of slow overnight charging, sale of vehicles with heat pumps, and remote vehicle management (e.g. for pre-heating) using mobile apps. Recommendations to support slow overnight EV charging provision (public and private) will also be essential to support this.

Implementation of EURO V fuel standards: Implementing this existing public policy (D4) would improve relative competitiveness of EVs and provide wider benefits (e.g. air quality).

Promotion of high potential segments

E-buses: Pilot new models of BEB implementation

Implementing further BEBs is only technically justified if using renewable energy (RE) and as part of bus priority corridors (a ‘Green Corridor’ concept). This ensures vehicles contribute to direct GHG reductions through fleet emissions (vs. EURO V diesel) and support further reductions by encouraging modal shift from more polluting modes (e.g. private automobiles and taxis). This study recommends implementation of a pilot Green Corridor using a revised business model (S16), which combines public vehicle leasing, a long-term operating concession, and RE charging through a microgrid (S6) using Charging as a Service (CaaS) (D5). This would achieve BEB transition at comparable cost to the current diesel fleet.

Commercial vehicles: Catalyse van and urban taxi implementation

Both light cargo vans and urban taxis show high economic and technical viability due to high daily usage, low marginal cost of use (energy), and exemption from circulation restrictions in Ulaanbaatar. To catalyse wider adoption of these segments, this study recommends pathfinder projects to establish replicable implementation models. Key actions include:

- Market development and coordination, including alignment of current vehicle owners and institutional entry points (e.g. associations, fleet owners) and locations (e.g. cargo hubs, distribution centres, airports, rail stations, shopping centres).
- Working with EV distributors to develop vehicle leasing models (S11) (including battery leasing), which are accessible to current vehicle owners.

² What is Nudge Theory? (n.d.). Imperial College London. <https://www.imperial.ac.uk/nudgeomics/about/what-is-nudge-theory/>

- Support charging models for pilot projects, including public charging (D12) and captive fleet charging (e.g. supporting CaaS models) (D5).

Energy sector reforms

Recommendations for the energy sector focus on i) a short-term reactive need to support grid connections and manage demand impacts; and ii) a strategic long-term role to unlock grid decarbonisation through market-based reform at both end-user and upstream levels.

Managing grid demand

Enabling grid connections for charging point roll-out: The impact of EVs upon total grid demand (1.9% in 2035 in a proactive scenario) will represent a very small proportion of background energy demand growth in that period (93% to 2035). At distribution grid level, individual EV demand will be accommodated within existing investment planning (with minimal adjustment for areas urban areas of higher EV penetration). For public charging, UBEDN will need to support charging point expansion while managing substation capacity limits. It will also need to develop mechanisms to share grid capacity information with EV charger planning efforts and CPOs, and create an efficient and transparent grid connection approval process for EV chargers (S7, S8).

Implement smart charging and energy tariff incentives to shift peak demand: The energy sector should coordinate design and implementation of smart charging protocols (S5) and develop a dedicated EV tariff (S9) to incentivise off-peak charging. While short-term EV grid impacts will be limited, early roll-out of an EV tariff will support an off-peak EV charging culture from the outset.

Grid decarbonisation

In the early stages of EV adoption, microgrid solutions incorporating RE can partially mitigate the issue of high carbon intensive grid. However, this is inefficient relative to utility scale RE generation and not generally suitable for home charging. As such, grid decarbonisation is critical for EVs to support Mongolia's decarbonisation efforts. Key recommendations are to i) create a functioning end user market for RE and ii) to revitalise utility-scale RE investment.

Create a functioning end user market in renewable energy: Mongolia should enable larger electricity users to directly purchase certified RE directly from generators through the grid (through 'wheeling') (S10), accompanied by Renewable Purchase Obligations upon these users aligned with RE targets and investment (S10). A similar approach is in use in India. This will drive additional RE investment and price competition for generation driven by private sector (obligated) demand in Mongolia, rather than the current Single Buyer framework.

Revitalise investment in grid decarbonisation: The Mongolian energy sector should seek to lower the cost of RE generation (S11) by creating an enabling investment environment and reducing risk premiums associated with the current framework. Key actions include: prioritising RE dispatch regulation and operation; improving efficiency and reliability of

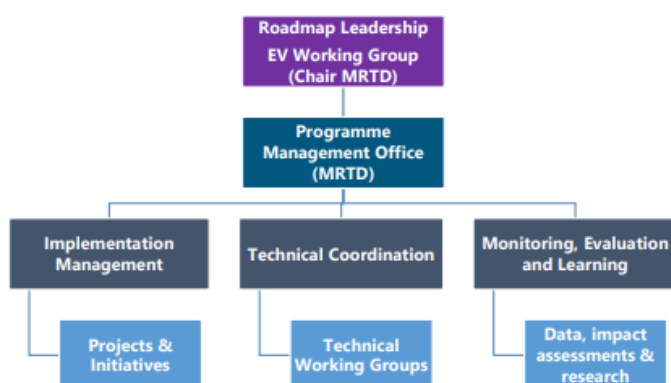
payment to RE generators; and investment in high voltage transmission lines between Ulaanbaatar and areas of highest RE potential to open up new investment opportunities.

Roadmap implementation

Whilst Mongolia has made positive steps in coordinating e-mobility deployment across sectors (most notably through the Prime Ministerial Resolution 108 of June 2023), a dedicated EV Program Management Office (PMO) is required to implement the recommendations for this roadmap. Its work should include coordinating projects and initiatives, taking ownership for resolving cross sectoral technical and regulatory issues, and provide monitoring, evaluation and learning (MEL) functions to ensure that EV transition results in decarbonisation and other policy aims.

The PMO should be hosted by Ministry of Roads and Transport Development (MRTD), with other technical stakeholders seconded to support specific initiatives. The Ministry of Environment and Tourism (MOET) should have a strong role in MEL, as the owner of the principle policy goals around decarbonisation and air quality.

Figure ES-2: Proposed implementation structure for E-Mobility Roadmap



Action Plan

The key priority actions for the immediate, short and medium term are highlighted in Figure ES-3 below. A full implementation plan can be found in Table 10-3 in the main document.

Figure ES-3: Priority roadmap actions

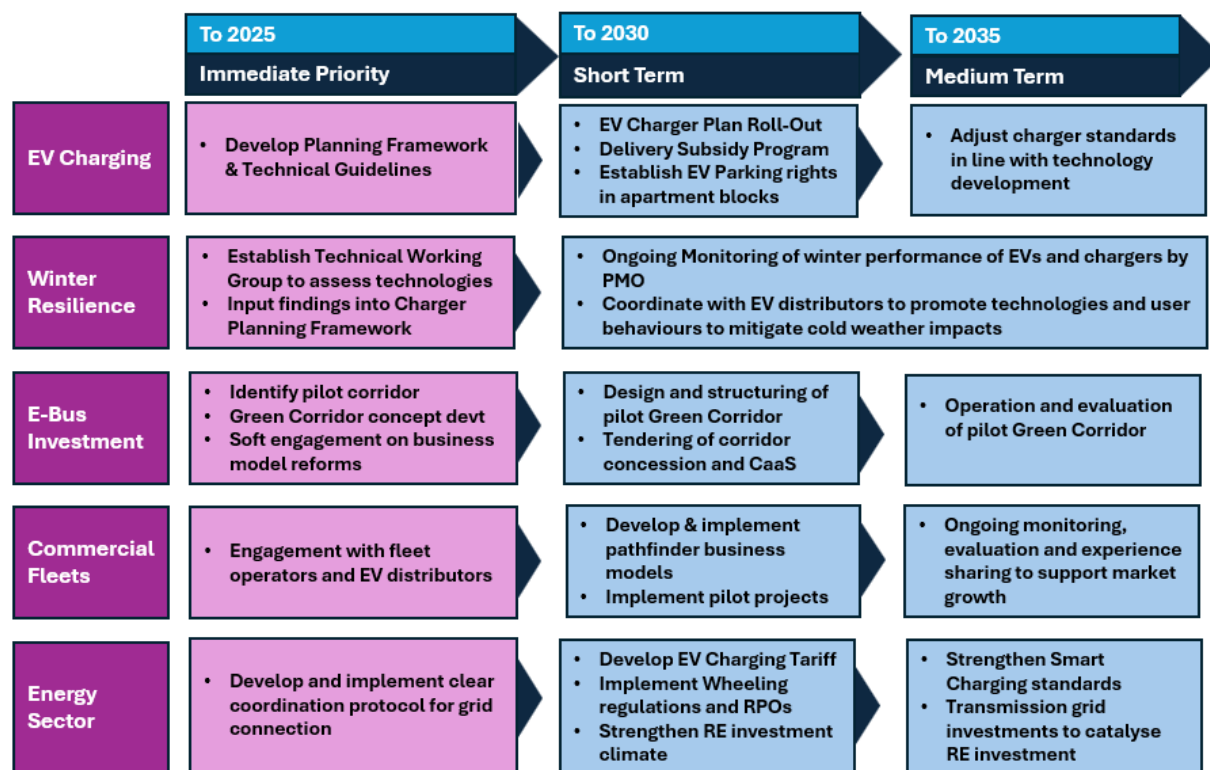


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Appendix C	Infrastructure Investment Costs for E-bus Upgrades
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Table of Abbreviations

Acronym	Meaning	Acronym	Meaning
BAU	Business-As-Usual	LRT	Light Rail Transit
BEB	Battery Electric Bus	MEL	Monitoring, Evaluation & Learning
BESS	Battery Energy Storage Systems	MGFC	Mongolia Green Financing Corporation
BMS	Battery Management System	MOET	Ministry of Environment and Tourism
BRT	Bus Rapid Transit	MRTD	Ministry of Road and Transport Development
BTB	Business-To-Be	MUB	Municipality of Ulaanbaatar
BYD	Build Your Dreams	MUB PTD	MUB Public Transport Department
CAA	Canadian Automobile Association	MNT	Mongolian Tugrik
CAGR	Compound Annual Growth Rate	NDC	Nationally Determined Contribution
CHPP	Combined Heat and Power Plant	OEM	Original Equipment Manufacturer
CPO	Charging Point Operator	PM	Particulate Matter
DBL	Dedicated Bus Lane	PHEV	Plug-in Hybrid Electric Vehicle
ELV	End-of-Life Vehicles	PT	Public Transport
EV	Electric Vehicle	RES	Renewable Energy Source
EPR	Extended Producer Responsibility	SDG	Sustainable Development Goals
EVAM	Electric Vehicle Association of Mongolia	TA	Technical Assistance
GCF	Green Climate Fund	TCO	Total Cost of Ownership
GHG	Greenhouse Gases	TOU	Time of Use
GoM	Government of Mongolia	UB	Ulaanbaatar
HEV	Hybrid Electric Vehicle	UBEDN	Ulaanbaatar Energy Distribution Network
HVAC	Heating, Ventilation and Air Conditioning	USUTP	Ulaanbaatar Sustainable Urban Transport Plan
ICEV	Internal Combustion Engine Vehicle		

1. Introduction

E-mobility in a Global Context

- 1.1 E-mobility is an important tool in global efforts to decarbonise the transport sector and offers extensive co-benefits ranging from air quality to energy security and industrial development opportunities. To date, high capital costs have seen the transition to electric vehicles (EVs) driven by public financial support with major investments in industrial economies (e.g. China, US, South Korea) and other countries pursuing particularly ambitious decarbonisation (e.g. Norway). Yet, as EV prices fall and deployment accelerates in developed economies, the popularity and market share of EVs in emerging markets is also likely to grow.
- 1.2 Mongolia is no exception to this trend and, while its national EV fleet remains small, this has grown over fivefold in the last five years³. Its wider ecosystem of EV importers, distributors and charging operators is also developing in size, knowledge and experience. With an import-oriented transport sector located adjacent to China, the shift to EVs and expansion of vehicle exports of its neighbour (and wider regional dynamics) will undoubtedly influence Mongolia's future vehicle supply in the coming years.
- 1.3 Assessing EV potential for Mongolia means we must acknowledge that the country presents a unique context for e-mobility transition. Its extreme winter climate requires validation of how suitable different EV technologies are in these conditions, and any adaptations required. Outside of Ulaanbaatar, extremely sparse population density and long distances between communities require questions of range and economic viability. Mongolia's carbon intensive coal-based electricity accounts for 89 percent of generation (as of 2019)⁴, and coal consumption in Mongolia is projected to grow⁵. In this context, the greenhouse gas (GHG) mitigation impact of EVs needs to be considered, while exploring how e-mobility can support renewable energy development and unlock climate finance opportunities.
- 1.4 Supporting and managing the growth of e-mobility means maximising opportunities (and potentially addressing challenges) across a range of sectors. This includes not just transport, but also energy, environment, finance and urban management. Coordinated planning and jointly owned strategies will be essential to understand and maximise the

³ MRTD. (2024). Increase the use of electric cars, electricity on the establishment of car charging centers. Mongolian Ministry of Road and Transport Development.

⁴ World Bank. (2023). Terms of Reference for The Study and Recommendation for Application of E-Mobility in Mongolia.

⁵ Hans et al. (2020). *The Mongolian electricity sector in the context of international climate mitigation efforts*. https://newclimate.org/sites/default/files/2020/03/Decarbonization_Pathways_Mongolia.pdf

opportunities from e-mobility and shape a market-led transition that supports both decarbonisation and other public policy goals.

Scope of this Study

- 1.5 This Technical Assistance (TA), *Study and Recommendation for Application of E-Mobility in Mongolia*, seeks to support the World Bank, Government of Mongolia, and Municipality of Ulaanbaatar in the development of a coordinated e-mobility roadmap. The study will assess the potential for e-mobility in Mongolia and identify the policies, incentives, and investments required to reach this potential in a way which supports the country's development agenda and aligns with global goals for decarbonisation.
- 1.6 This E-Mobility Roadmap is the second and final deliverable of TA which, building on the first (E-Mobility Assessment), identifies two scenarios for E-Mobility Development in Mongolia, and makes recommendations for policy, regulatory and operational actions to achieve these. This E-Mobility Roadmap is based on extensive engagement and discussion with public and private stakeholders in Mongolia.

E-Mobility Roadmap Development

- 1.7 E-Mobility Roadmaps are a tool through which to bring together stakeholders from across sectors to understand the potential for e-mobility, the challenges and bottlenecks to realising this, and to identify, agree and coordinate the required actions to address them. Figure 1-1 shows the key steps in this process. This document builds on understanding and vision-building within the E-Mobility Assessment, moving towards scenario building, impact modelling and action planning.

Figure 1-1: E-mobility roadmap



Structure of the Remainder of this Report

1.8 The remainder of this report is structured as follows:

- **Section 1: EV Readiness**
 - **Chapter 2 outlines Mongolia's readiness for e-mobility.** It summaries analysis from the E-Mobility Assessment of existing EV deployment, EV technology suitability in Mongolia, and the readiness of the vehicle market, energy sector readiness, environmental policy and urban mobility.
 - **Chapter 3 develops two future growth scenarios for an 'enabling' and 'proactive' approach,** as well as a baseline growth projection. This is based upon detailed assessment of the readiness of different vehicle segments and use cases in Mongolia (including private automobiles, light commercial vehicles, and urban buses).
 - **Chapter 4 provides modelling of these growth scenarios,** projecting both future vehicle numbers, their energy grid impacts, and wider impacts including upon GHG emissions, fuel consumption and health benefits.
- **Section 2: EV Roadmap Recommendations**
 - **Chapter 5 provides recommendations for demand-side incentives and actions** for EVs in high readiness sectors.
 - **Chapter 6 provides recommendations for technology and user behaviours** to support the functionality of EV technology in the Mongolian climate context.

- **Chapter 7 provides recommendations to support the energy sector** to mitigate the grid impacts of EVs and to improve the carbon mitigation benefits of EV charging.
- **Chapter 8 provides recommendations on integration of EVs and environmental policy**, both in terms of carbon reduction and local environmental impacts, such as air pollution and end-of-life battery management.
- **Chapter 9 provides recommendations for e-mobility within the context of sustainable urban mobility**, considering Ulaanbaatar's wider mode shift goals in response to traffic congestion and poor accessibility.
- **Chapter 10 provides a suggested institutional structure** for the implementation of the e-mobility and roadmap. This is followed by a strategic action plan, to organise and prioritise the recommendations in this report.
- **Section 3: E-Bus Business Models**
 - **Chapter 11 provides recommendations for an e-bus business model** providing detailed analysis of the urban bus business model.

Section 1

EV Readiness



a company of Royal HaskoningDHV

2. Mongolia's E-Mobility Readiness

Introduction

- 2.1 The E-Mobility Assessment, which formed the first deliverable of this TA, provided a holistic review of Mongolia's readiness for e-mobility and opportunities for EV deployment to accelerate transport sector decarbonisation. Using an exploratory approach, the assessment interviewed stakeholders across the transport, energy, and environment sectors to understand the key challenges, opportunities and gaps from a technology, policy, market, and economic perspective. This section summarises the key findings from this assessment as relevant to the development of recommendations within an e-mobility roadmap, with an overview table provided later in the chapter.

Current State of EV Deployment

- 2.2 E-mobility is in the early stages of development in Mongolia. However, a growing ecosystem is developing for EVs in some vehicle sectors.

Vehicle deployment

- 2.3 As of December 2023, 1,061 EVs were in operation in Mongolia³. While this represents only 0.1% of the vehicle fleet, it represents growth of 243% since 2020⁶. While limited breakdown of vehicles is available, these include private automobiles (both new and used), light freight vehicles (vans), and urban buses (both battery electric buses (BEB) and a number of trolleybuses). Among the major segments:
- A large number of used Nissan Leaf EVs, predominantly imported used from Japan (92% of this segment is imported from Japan⁷). An estimated 95-98% of automobiles imported to Mongolia are used vehicles, with 36% of vehicles at least 10 years old on import⁸.
 - New vehicles (including a small light van pilot) are predominantly Chinese, with a small number of high-end vehicles of other origins. New vehicle retailers report strong sales of EVs in Ulaanbaatar (with estimates ranging from 10-45% of current sales). However, this segment represents a small proportion of the market (8%⁹).

⁶ Mongolian Ministry of Foreign Affairs. (2024). *Vehicle Data* [Dataset].

⁷ National Statistics Office of Mongolia. (2024). *THE NUMBER OF IMPORTED CARS, by country, by type, by year* [Dataset]. https://www.1212.mn/en/statistic/statcate/573059/table-view/DT_NSO_1200_013V5

Used light vehicle imports from Japan are driven by Mongolia's acceptance of right-hand drive vehicles.

⁸ National Automotive Vehicle Centre. (2023). *Vehicle Import Data* [Dataset].

⁹ MSM. (2024). *Mongolia Vehicle Market Overview* [Dataset].

- 55 BEBs from two Chinese brands, Nanjing and Yinlong. All are operated by public bus operators in Ulaanbaatar, benefiting from synergies with 40 years of experience in operating electric trolleybuses.
- 2.4 A supply chain exists for purchase of both new and used EVs within Mongolia (in Ulaanbaatar), which is described in “Market availability of EVs” below.

Charging infrastructure

- 2.5 In this early stage of EV transition, the majority of EVs are understood to be charged through captive EV chargers (either at residential locations or fleet depots). However, a growing number of public EV charging points have been installed within Ulaanbaatar. These include the following EV charging modalities:
- Commercial fuelling station operators (e.g. PetroVIS) at several of their sites within Ulaanbaatar. Additionally, several EV retailers have installed (or plan to install) EV charging stations driven by a desire to grow the EV market.
 - Destination charging, such as that provided by E-Mart, a Korean hypermarket chain, which has provided a charging station at its Khan-Uul branch.
 - Publicly provided EV charging stations provided by the Municipality of Ulaanbaatar (MUB), with 25 charging facilities installed around the city and an ordinance signed for EV charging facilities in 71 public car parks through private operators.
- 2.6 All charging points are currently located in Ulaanbaatar. Interviewed vehicle retailers, however, report that a key barrier to EV uptake is charging coverage in the areas in the immediate vicinity of the city, which include popular leisure destinations for the capital’s residents. One retailer, LEAF Center, is reportedly planning the deployment of commercial charging points on key highways outside of Ulaanbaatar (UB).

Standards and coordination

- 2.7 Mongolia has developed and implemented EV vehicle standards¹⁰ and EV charging infrastructure standards¹¹ for EVs, which were assessed in depth as part of the E-Mobility Assessment. Standards for both vehicles and chargers are open to all major EV and charging technologies, which provides an open market for e-mobility providers in this early stage of development. But this may create challenges of interoperability and quality issues undermining confidence and growth in the EV market. Notable gaps in

¹⁰ Government of Mongolia. (2018). *MNS 6728: 2018 BEV. General Technical Requirements for Performance and Safety of EV.*

¹¹ Government of Mongolia. (2019). *MNS 6758: 2019 Installation and placement of EV charging station types and equipment. General requirements.*

standards include an absence of standards for electric motorcycles and plug-in hybrid (PHEV) technology.

- 2.8 A remaining consideration is the issue of EV battery waste, which is already a priority transport sector issue given the high proliferation of ageing hybrid electric vehicles (HEVs) in Mongolia. In terms of EV market development, the Ministry of Environment and Tourism (MOET) has facilitated EV marketing events and announced the formation of the EV Association of Mongolia (EVAM). Cross-sectoral policy coordination is being promoted through the Office of the Prime Minister, mandating the creation of a Working Group chaired by Mr Byambatsogt of the Ministry of Road and Transport Development (MRTD).

CONCLUSION: CURRENT ECOSYSTEM

While e-mobility is in the very early stages in Mongolia, there is a growing experience of EV use across different EV market segments. The growth of EVs has been driven by the private sector, with the public sector providing and enabling regulatory environment. EVs are almost exclusively deployed in Ulaanbaatar.

Technology Readiness

- 2.9 The key technology suitability concerns identified by stakeholders in the Mongolian context relate to climate conditions and range anxiety due to the long distances between trip attractors outside of Ulaanbaatar.

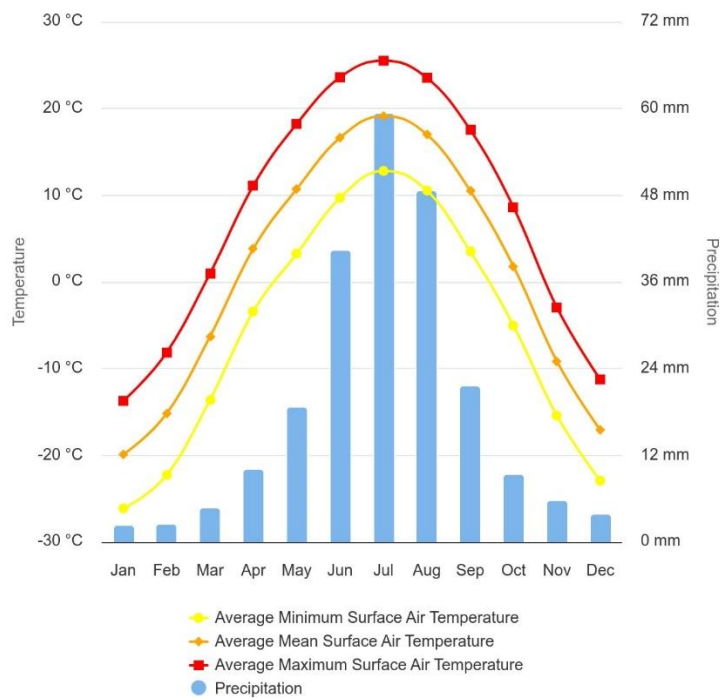
Climate conditions

- 2.10 Mongolia's climate is notable for its long, cold winter periods, during which average temperatures in Ulaanbaatar are -21°C ¹². Temperatures often fall below -40°C , and climate change is likely to increase the frequency and severity of extreme temperatures.

¹² World Bank Climate Change Knowledge Portal. (n.d.). <https://climateknowledgeportal.worldbank.org/country/mongolia/climate-data-historical#:~:text=Average%20temperatures%20range%20between%20around,varies%20dramatically%20throughout%20the%20year.>

Figure 2-1: Mongolia average annual temperature range

Monthly Climatology of Average Minimum Surface Air Temperature, Average Mean Surface Air Temperature, Average Maximum Surface Air Temperature & Precipitation 1991-2020; Mongolia



Source: [World Bank](#)

2.11 EV users in Mongolia and other regions with similar extreme climates (e.g. Norway and Midwest US) have reported the following challenges:

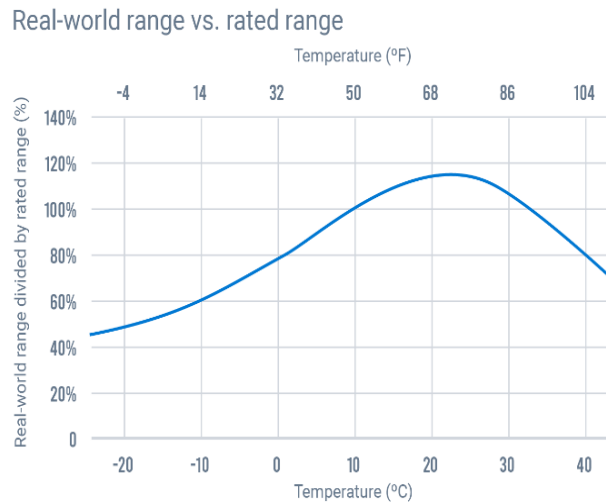
- Reduced EV range**, both due to impacts on battery performance and the energy demand required for heating. Global empirical data on these impacts (using data from 5.2m journeys made by 4,200 EVs) shows a temperature of -20°C reducing range to 50% of rated range¹³. In Ulaanbaatar, temperatures have been reported to affect all vehicle segments to some extent, with old and entry-level vehicles (e.g. Nissan Leaf) reducing their range to below 100km (likely to affect market appeal and prevent use in commercial operations). However, newer and higher-end EVs are likely to retain a charge suitable for extensive urban use.

Public transport (PT) operators report BEBs require additional charging during winter months, affecting operating efficiency. To mitigate these effects, BEBs operating in UB are equipped with diesel cabin heaters. Opportunity charging could also be mitigated with opportunity charging.

¹³ Argue, C. (2023, August 17). To what degree does temperature impact EV range? *Geotab*. <https://www.geotab.com/uk/blog/ev-range/>

Country-specific examples also exist from Norway and Kazakhstan, showing latest Yutong E12 buses achieving a range of 374km at -25°C in Astana, and power consumption of 1.56kWh/km in Kirkenes, Norway¹⁴ (equivalent to 189km on a full battery¹⁵).

Figure 2-2: EV Temperature Range Curve¹³



- EV fast charging performance**, with the Battery Management System of vehicles limiting the charging rate of DC (fast) chargers to reduce battery wear. This substantially increases the time taken for batteries to charge using fast charging stations. Research results show that the efficiency of most commercial chargers reduces to 80-90% under -15 °C and to 40-50% under -25 °C¹⁶. This is consistent with recent widely reported user experiences in the US Midwest during extreme cold weather in January 2024¹⁷. Additionally, some vehicles initially reject fast charging input due to battery temperature. Various mechanisms exist to overcome this challenge, with experience from Norway of the need for user education around battery 'preconditioning'¹⁸ to warm the battery prior to fast charging. Promotion of overnight charging, including in covered areas, can further address this issue.

¹⁴ Editorial Staff. (2024, February 20). *Yutong U12 e-bus underwent testing in Norway and Kazakhstan, with dedicated technologies for cold climate*. Sustainable Bus. <https://www.sustainable-bus.com/electric-bus/yutong-testing-norway-cold-climate-technologies/>

¹⁵ Model E12 – Yutong Eurobus Scandinavian AB. (n.d.). <https://yutongeurobus.se/products/model-e12-2/#tab-id-2>
295 kWh battery

¹⁶ Bayram, I. S. & Department of Electronic and Electrical Engineering, University of Strathclyde. (2021). Impacts of Electric Vehicle Charging under Cold Weather on Power Networks. In *IEEE* (pp. 1–10) [Journal-article]. https://strathprints.strath.ac.uk/79154/1/Bayram_UPEC_2021_Impacts_of_electric_vehicle_charging_under_cold_weather_on_power_networks.pdf

¹⁷ Garsten, E. (2024, January 19). Perfect storm to blame for cold weather EV charging woes, study says. *Forbes*. <https://www.forbes.com/sites/edgarsten/2024/01/19/perfect-storm-to-blame-for-cold-weather-ev-charging-woes-re-new-study/?sh=3678e09c3947>

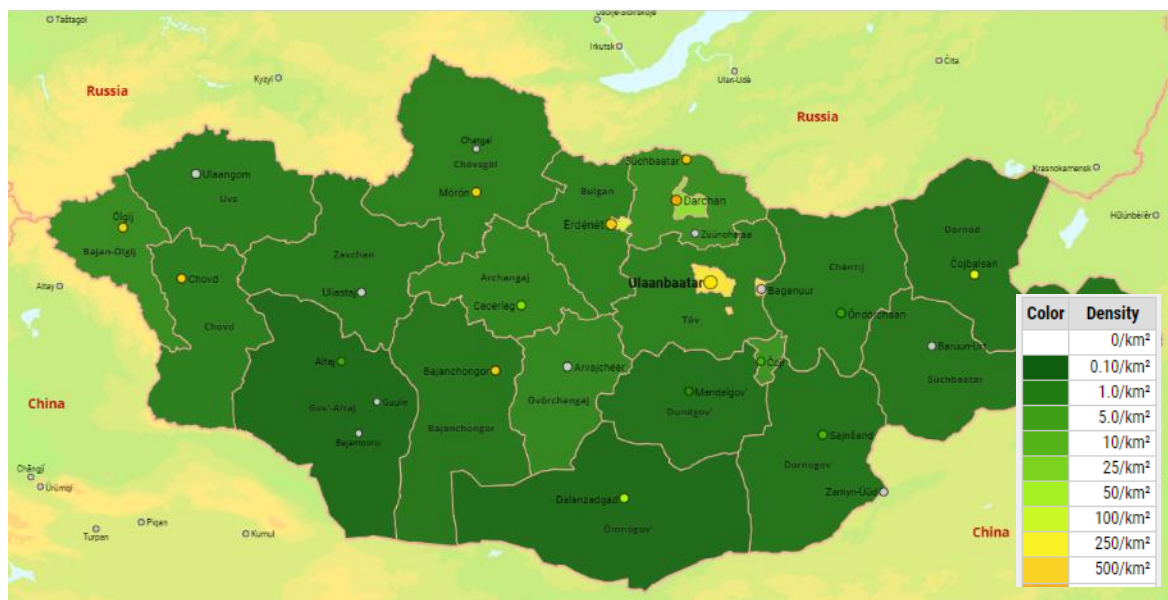
¹⁸ Dnistran, I. (2024, January 19). Here's why Norway hasn't had trouble with winter EV charging. *InsideEVs*. <https://insideevs.com/news/705338/norway-winter-ev-charging-no-trouble/>

- **Overall demand upon charging infrastructure and energy** during winter months will substantially increase with EV adoption, due to the combined impacts of the two points above.
- 2.12 Finally, it should be noted that the impact and suitability of vehicles to the Mongolian climate is not an issue limited to EVs. Extreme cold also creates problems for starting internal combustion engine (ICE) vehicle engines, for which many fleet operators (e.g. bus operators) store vehicles in undercover depot sheds. Particularly low temperatures can also freeze ICE fuel pumps¹⁹.

Spatial population distribution

- 2.13 Population distribution in Mongolia means that outside of Ulaanbaatar, population and activity locations are extremely dispersed. The Tov province which surrounds the capital has a population density of 1 person/km². Other than Ulaanbaatar, Mongolia has only three other population centres above 50,000 people, specifically:
- Moron (134,000, 775km from UB)
 - Erdenet (107,000, 382km from UB)
 - Darhan (75,000, 225km from UB)

Figure 2-3: Population density in Mongolia²⁰



- 2.14 Sparse population presents major economic and technical challenges for these areas, including an increased importance of EV range, increased cost for charging point

¹⁹ Allan, T. (2024, February 13). *Turning down the dial on cold weather anxiety for EVs in Canada*. Electric Autonomy Canada. <https://electricautonomy.ca/policy-regulations/opinions/2024-02-13/cold-weather-ev-anxiety-canada/>

²⁰ Mongolia: Provinces, cities & urban settlements - population statistics, maps, charts, weather and web information. (n.d.). <https://www.citypopulation.de/en/mongolia/cities/>

provision (and lower demand); increased actual and perceived technology risk for EVs (access to repair and maintenance; importance of reliability). These factors make e-mobility practically unfeasible for Mongolia outside of the capital (as validated during the January 2024 Mission Workshop). Conversely, for Ulaanbaatar, the implications of sparse population outside of the city mean that long distance journeys outside of UB are not a major consideration for private vehicle owners. It is important to note, though, that there is a strong culture of leisure and recreation in remote rural areas in the region surrounding the capital.

CONCLUSION: TECHNOLOGY READINESS

Mongolian and international experience clearly demonstrates that electric vehicle technology is compatible with Mongolian climate conditions, subject to certain adjustments. It will be important to consider the vehicle hardware and behavioural adjustments necessary to maximise performance and functionality, and to consider the additional energy and charging infrastructure required.

In the current context, significant adoption of e-mobility outside of Ulaanbaatar is not likely to be feasible in techno-economic terms, considering the high investment costs and importance of actual and perceived vehicle range and technical reliability to remote communities. Therefore, UB should be prioritised for investments and early adoption measures.

Vehicle Market Readiness

2.15 The E-Mobility Assessment considered vehicle market readiness based on the following readiness drivers:

- Economic competitiveness and financial accessibility
- Consumer acceptability of EVs
- Market availability

Economic competitiveness and financial accessibility

2.16 The economic competitiveness of different EV segments was assessed through the Total Cost of Ownership (TCO). TCO analysis considers the lifetime cost of EVs in the Mongolian context, including capital costs, taxation, and operational costs, which is expressed in a cost per km. Considering the cold weather conditions in Mongolia, the TCO analysis also includes a reduction of 20% in vehicle efficiency in line with the evidence outlined in the main report. The study has considered ICEV/HEV/EVs as follows:

- Private cars, including three sub-markets:
 - ‘Mass market’ used vehicles: Older Toyota Corolla, Toyota Prius and Nissan Leaf, each with 7 years of life from import.
 - Mid-market used vehicles: Lexus NX, Toyota Harrier and BAIC EU5, each with 10 years of life from import.
 - New vehicles: Mercedes C-Class, BYD Han, each with a full 15 years of life from import (no HEV).
- Urban taxis and Private hire vehicles (as mass market/new vehicle above, with 150 daily km)
- Urban buses (12m): New 12m Yutong ZK6108 and E12 (no HEV) (246/220km/day)
- Minibuses: Mercedes Sprinter and Altas Novus Ecoline (180km/day)
- Light freight vehicles: Ford Transit and BYD T3 (180km/day)

2.17 The findings from the TCO analysis are shown in Table 2-1, the key findings of which include:

- Mass market automobiles (representing 95% of automobiles and majority of the national vehicle fleet) have a slightly higher (~6%) lifetime cost compared to their ICE vehicle equivalent, however a much greater (28%) differential compared to HEVs (which are predominant in this segment).
- Mid-range and new segments EVs are already competitive with ICE and HEV, with low energy costs but less relative capital cost differential across premium brands. However, these segments represent a small proportion of the overall automobile market in Mongolia (estimated at less than 5%).
- High-use light commercial vehicle segments are highly competitive with ICE (and HEV as applicable). This is due to the savings of transitioning from petrol and diesel in these high mileage segments given that Mongolia’s end user electricity costs are among the lowest in the world (at US\$0.04/kWh). Also notable is the exemption of EVs from Ulaanbaatar’s circulation restrictions, increasing the intensity of use.
- Public transport vehicles are not yet competitive with ICE vehicle variants, and intraurban buses and minibuses both had a significantly higher TCO (although sensitivity analysis found that the differential would be reduced to 2% with a 20% increase in bus speeds).

Table 2-1: TCO analysis result summary

Vehicle segment	TCO (USD/km)	ICE vs EV differential

		ICE	Hybrid EV	EV	Absolute (USD/km) ²¹	Percent (%) ²²
Private automobile	Mass Market	0.260	0.214	0.275	0.015	6%
	Mid-Range	0.367	0.338	0.269	-0.099	-27%
	New	0.571	-	0.578	0.007	1%
Taxi	Urban Taxi	0.186	0.175	0.139	-0.047	-25%
	Private Hire	0.248	-	0.209	-0.039	-16%
Bus	Intraurban (12m)	0.792	-	0.889	0.096	12%
	Minibus	0.600	-	0.718	0.121	20%
Light freight	Van	0.229	-	0.162	-0.067	-29%

Market availability of EVs

- 2.18 Mongolia has a number of EV suppliers for both new and used vehicles, mirroring the business models employed to ICE vehicles. MOET reported being aware of 15 companies in Mongolia engaged in the supply of EVs who had, as of June 2023, agreed to the formation of the EV Association of Mongolia (EVAM).

New vehicle market and supply chain

- 2.19 There are new vehicle distributors for BYD, Mercedes and GD (an emerging Chinese brand) already established in Mongolia, with Hyundai reported to be setting up distribution in 2024. Original Equipment Manufacturers (OEMs) are providing an ~8-year warranty on new EV purchases, with distributors providing routine maintenance and servicing. Mongolian BEBs are typically procured through international tender. However, OEMs including Skywell and BYD have national distribution networks.

Second hand market and supply chain

- 2.20 A number of used EV distributors are also present in the market, including Leaf Centre (no official relation to Nissan, producer of the Leaf EV). To date, Nissan Leaf has been the main EV brand, imported from Japan under the same market incentives (supply of

²¹ Negative value indicates EV TCO is less than ICE TCO.

²² As a percentage of ICE TCO.

used vehicles with limited Japanese or international market) as is the case for Japanese hybrid and ICE vehicles, alongside significantly reduced excise tax for EVs.

EV financing

- 2.21 Financing is available for both new and used EV imports both through commercial banks and other financial services providers. Commercial banks offer specific EV loan schemes with concessional rates using financing from the Green Climate Fund (GCF)²³ via the Mongolia Green Financing Corporation (MGFC). These offer interest rates 4-5% lower than typical ICE vehicle or hybrid financing (14-15% annually). Financing for used EVs exists, with Leaf Centre quoting rates in a range of 3% for up to 50m MNT (US\$14,000) and 14% beyond that. These tend, however, to have a more limited loan duration (no greater than two years).
- 2.22 The sensitivity and financing capacity of mass market segment is a potential accessibility/acceptability issue for EVs. For example, the capital investment cost for a Nissan Leaf (compared to an equivalent hybrid Prius) would be approximately 30-40% higher in the local market. For larger and more capital-intensive vehicles (e.g. BEBs), purchase costs (including battery) approach three times the ICE vehicle equivalent, making local private financing options prohibitively expensive (see Section 11, E-Bus Business Models).

Availability of mass-market equivalent specification EVs

- 2.23 A final consideration for the mass market segment is the availability of EVs of equivalent age and specification to ICE vehicles (typically 7+ years old). While this presents a short-medium term constraint to EV adoption in many contexts, it is of particular importance in Mongolia given its used vehicle segment is dominated by Japanese imports.
- 2.24 Mongolia's acceptance of left-hand drive vehicles give Mongolian consumers access to low-cost used vehicles. Yet Japan is one of the slowest EV adopters, with EV sales just 1.1% of total Japanese sales in 2020²⁴. This equates to 5,500 vehicles, which is less than 15% of Mongolia's annual imports. While the increased dominance of the Chinese automobile industry (and recently opened used vehicle export sector) may have some impact on its long-term trajectory, a mass supply of used EVs seems unlikely in the short-medium term.

²³ The [Green Climate Fund \(GCF\)](#) – a critical element of the historic Paris Agreement – is the world's largest climate fund, mandated to support developing countries raise and realize their Nationally Determined Contributions (NDC) ambitions towards low-emissions, climate-resilient pathways. (Green Climate Fund, n.d.)

²⁴ *Japan transition to electric vehicles*. (2021, July 7). International Trade Administration | Trade.gov.
<https://www.trade.gov/market-intelligence/japan-transition-electric-vehicles>

Market acceptability of EVs

- 2.25 Higher range EVs have had a positive entry to the market. Advertising and user experience highlights the low operating costs while claimed ranges of 450km in urban traffic are sufficient for destinations in the region around Ulaanbaatar. Given the remote geography of Mongolia, there are relatively few intercity/long distance journeys, and so EV range covers the vast majority of trips. The prevalence of dedicated parking spaces in modern apartment blocks in the city enables the installation of overnight home charging points. While energy demand for individual (or even several) EV home chargers can be accommodated by existing apartment block grid connections, as EV penetration increase, the cumulative impact may result in pressures at the building and substation level.
- 2.26 More mass market EV options, particularly the Nissan Leaf, have had a mixed market response based upon consultations with the Leaf Centre²⁵. Older Nissan Leafs have often suffered from poor range, as low as 75km in the extreme winter temperatures. As a result, Leaf Centre (responsible for 65% of EV imports) has ceased their importation and instead promotes the Chinese-made BAIC EU5 as the entry-level second-hand sedan EV (a three-year-old version of which costs approximately \$19,000) and offers a range of up to 400km.

CONCLUSION: MARKET READINESS

Low energy costs support economic viability of high-use commercial segments, although BEB viability is negatively impacted by slow bus speeds (congestion).

There is an established and growing distribution network for both new and used EVs and formal EV financing is available.

In the short-medium term there is restricted supply of competitive mass market EVs, particularly considering the market prevalence of Japanese vehicles.

Market perception of EVs in Ulaanbaatar is reportedly positive. However, care is required to ensure suitability of older vehicles for Mongolian context.

Urban Mobility Readiness

- 2.27 Ulaanbaatar has initiated a reform of the public transport sector since 2015 and made several proposals to develop mass transit schemes (including Bus Rapid Transit (BRT), Light Rail Transit (LRT) and Metro) and has designated dedicated bus lanes for public transport (although these are not always enforced). This work is ongoing, with the support from development partners including the World Bank supported Ulaanbaatar

²⁵ Leaf Centre is an independent local importer not formally affiliated to Nissan.

Sustainable Urban Transport Programme (USUTP), as part of a vision of a more sustainable transport system for Ulaanbaatar. E-mobility forms an important part of this vision.

- 2.28 For instance, MUB's Public Transport Department (MUB PTD) has piloted a total of 55 BEBs, currently in operation with two public bus operators using opportunity charging infrastructure installed in operator depots. Vehicles are equipped with diesel heating for the winter months, which reduces the range impact of the cold climate.
- 2.29 While operators are satisfied with the operating experience of the BEBs, the analysis conducted within the E-Mobility Assessment found that:
- BEBs have GHG emissions similar to modern Euro V ICE (diesel) buses (see Figure 2-5), due to Mongolia's predominantly coal-based energy mix (detailed in Energy generation below) and use of diesel for heating BEBs.
 - The BEB TCO is significantly higher than the ICE bus equivalent, including high capital cost (three times higher) and lower in-service mileage (due to use of depot charging).
 - Low vehicle speeds (lack of bus priority) affect both ICE buses and BEBs, but the higher capital intensity of BEBs creates greater opportunity to improve performance through effective bus priority schemes.
- 2.30 Beyond the operational and financial challenges of BEBs, it's important to contextualise BEBs and other forms of e-mobility in terms of their ability to tackle Ulaanbaatar's goal of more sustainable urban mobility. In the Avoid-Shift-Improve hierarchy of transport decarbonisation, a transition in technology to e-mobility falls under "improve", i.e. the lowest priority category.
- 2.31 Transitioning to EVs alone is not a replacement for the higher priority (and potentially more impactful) imperative to reduce travel demand ("avoid"), followed by the need for a modal shift ("shift") towards more sustainable forms of transport (e.g. from private automobiles to public transport). This is recognised by the MUB and is currently being promoted by the World Bank USUTP program and others.
- 2.32 For instance, the city has run a policy which has restricted vehicles' access to downtown Ulaanbaatar based on the last digit of their number plate²⁶ (an "avoid" policy). EVs are fully exempt from these restrictions, and are denoted by green number plates, to avoid them being fined by number plate detection cameras or traffic officers²⁷.

²⁶ Tumurbaatar, D. (2022). *Temporary driving restriction reduces traffic congestion by 40%*. PressReader. <https://www.pressreader.com/mongolia/the-ub-post/20220902/281496460103936>

²⁷ Dulguun, B. (2017). *Electric cars exempted from driving restrictions and road tax*. PressReader. <https://www.pressreader.com/mongolia/the-ub-post/20170823/281479276535996>

- 2.33 However, the challenges of rapid growth, low density expansion, sprawling land use, a sparse road network and sectoral coordination has presented challenges to shifting policy into significant improvement of public transport services. An efficient, high quality public transport network providing mobility to Ulaanbaatar's residents is a key requirement to make the city's mobility sustainable, alongside supporting measures such as institutional strengthening, efficient road space use, and promotion of non-motorised transport.
- 2.34 There is a danger that encouraging e-mobility, particularly in the private automobile market, could further the dependence on single-person automobile usage, which is a significant cause of UB's severe congestion problem. E-mobility should be seen as an opportunity to decarbonise residual motorised travel demand alongside efforts to "avoid" and "shift" (rather than an alternative).
- 2.35 Given the above, there is no clear rationale for further BEB investment (over, for example, the recent EURO V diesel fleet renewal). For BEB to have greater readiness, it will be necessary for supporting measures to be introduced alongside BEB fleet renewal (e.g. as part of bus priority schemes, contractual performance improvement, alignment with green energy sources). BEBs should be seen as a means to an ends (a more effective and popular public transport system which attracts users from private automobiles), rather than an ends in themselves.

CONCLUSION: URBAN MOBILITY READINESS

Ulaanbaatar has demonstrated the deliverability of BEBs in the Mongolian context. However, there is no clear rationale for their expansion in the current energy and operating context.

BEBs may be suitable when accompanied by other improvements, such as bus priority, improvements to the operating model, and renewable energy sources.

"Avoid" and "Shift" policies, such as the number plate restriction in downtown UB and policies to promote public and non-motorised transport over automobile usage may offer great public cost-benefit compared to investment in e-mobility in many cases.

Energy Sector Readiness

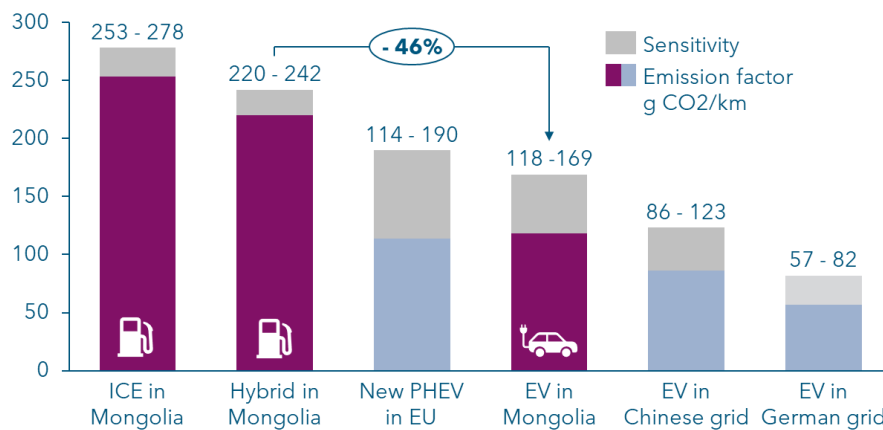
Energy generation

- 2.36 Of Mongolia's domestic energy generation in 2022, 91% was from coal and 9% (649 GWh) from renewables (wind, solar, and hydro). Some 19% of total energy use was imported, covering seasonal generation shortages and year-round peak load

balancing. The Mongolian grid's focus on coal powered Combined Heat and Power Plants (CHPP) means Mongolia has a CO₂ equivalent emission of 742 g CO₂/kWh²⁸, among the highest in the world.

- 2.37 As shown in Figure 2-4, emissions modelling shows that EV passenger cars nevertheless emit 46-53% less than the ICE and HEV counterparts²⁹.

Figure 2-4: Emission factor of passenger cars across ICE, Hybrid and EV



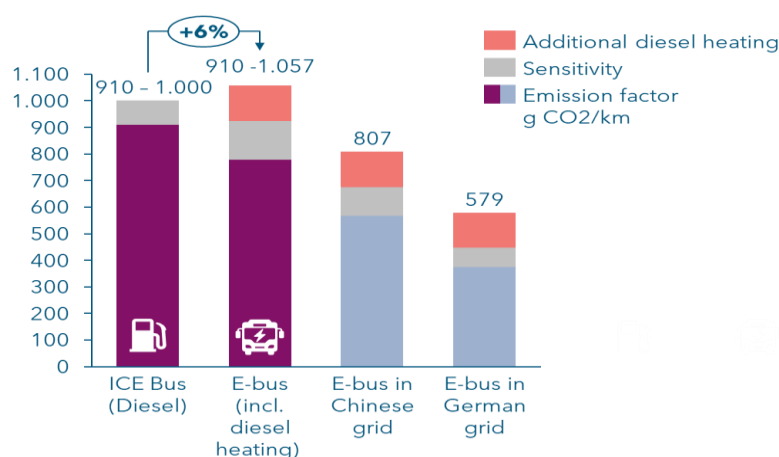
- 2.38 By contrast, Figure 2-5 shows that e-buses with diesel heating result in no significant impact on GHG emissions compared to diesel (potentially slightly higher). This is because electric heavy vehicles³⁰ tend to have lower energy efficiency per kilometre (0.16 kWh/km for passenger EVs versus 1.25 kWh/km for e-buses).

²⁸ Statista. (2024, May 24). *Electricity sector carbon intensity APAC 2021, by country*.

<https://www.statista.com/statistics/1299708/apac-carbon-intensity-power-sector-by-country/>

²⁹ This assessment relies on data related to vehicle mileage and efficiency, taking into consideration driving behavior and local conditions in Mongolia. It includes ICE vehicles achieving 9.1 km/liter, Hybrid 10.5 km/liter and EV 4.4 km/kWh.

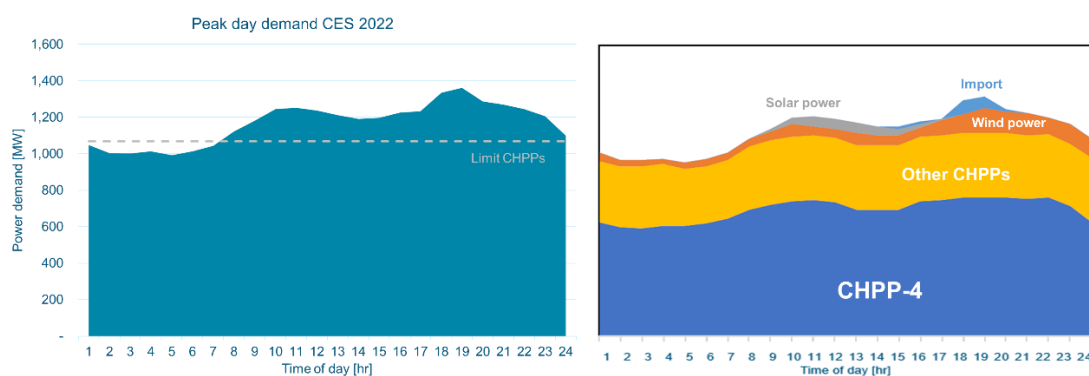
³⁰ pManifold. (n.d.). *All EV segments are Green: A myth or reality?* <https://www.pmanifold.com/blogs/all-ev-segments-are-green-a-myth-or-reality/>

Figure 2-5: Emission factor of ICE and EV buses in Mongolia³¹

Energy supply

- 2.39 Addressing peak energy demand is the key challenge to both Mongolia's energy grid actors and economic governance. From a grid perspective, overall national generation does not meet peak demand (with the remainder sources from imports). Investment in the distribution networks in Ulaanbaatar has not met the rapid overall pace of the city, resulting in the high peak loading of existing distribution infrastructure in many areas. Furthermore, many informal Ger areas have limited access to grid energy. Managing demand peaks is partially managed by high coverage of Time of Use (ToU) billing with approximately 3.1m billed ToU months in 2022.

Figure 2-6: 8.15 Power demand of the CES for a peak winter day in 2022



³¹ This assessment relies on data related to vehicle mileage and efficiency, taking into consideration driving behavior and local conditions in Mongolia. It includes ICE busses achieving 2.9 km/liter, and EV 0.8 km/kWh (incl. battery degradation of 20% in the winter) and an additional 0.05-liter diesel per km in the wintertime for heating purposes.

Economic governance

- 2.40 The Mongolian energy system operates under a Single Buyer model, with National Dispatch Centre (NDC) in the role of energy purchasing. Key characteristics of this relevant to E-mobility include:
- While Mongolia's end user tariffs are among the lowest in the world, energy imported during peak demand times is responsible for a structural deficit within the system. Typical EV charging patterns (e.g. home charging) would exacerbate system deficits without economic (ToU) or technological (smart charging) solutions.
 - Mongolia has an established regulatory framework for the integration of Renewable Energy Source (RES) generation, with numerous RES project implemented in recent years. However, RES cost relative to CHPP investment has seen future projects stalled. The Single Buyer model means that there is no end user market for RES, preventing e-mobility fleet operators or Charging Point Operators (CPO) from purchasing RES to lower the carbon intensity of energy supply.

CONCLUSION: ENERGY SECTOR READINESS

The high carbon intensity of the Mongolian energy grid is a challenge for the role of e-mobility in decarbonising the transport sector, particularly buses.

The single buyer energy model prevents the purchase of renewable energy through the grid.

Underinvestment in energy distribution in Ulaanbaatar presents challenges to expansion of e-mobility.

Environment Sector Readiness

Urban air quality

- 2.41 Ulaanbaatar is one of the most polluted capitals in the world, with 27 times the level of PM_{2.5} the WHO recommends as safe³². While this is principally due to coal burning by power plants and residents of ger areas (informal neighbourhoods) for cooking and heating, the transport sector contributes significantly (e.g. approximately 20-30% of annual average PM₁₀ emissions)³³. The underlying cause of this is high (and rapidly

³² UNICEF. (n.d.). *Climate change - Mongolia*. Retrieved July 31, 2024, from <https://www.unicef.org/mongolia/environment-air-pollution#:~:text=Ulaanbaatar%20%E2%80%93%20home%20to%20half%20of,level%20WHO%20recommends%20as%20safe.>

³³ Dugerjav, G. (2023). *Decarbonization of Public city Transport in Ulaanbaatar, Mongolia*. https://www.itf-oecd.org/sites/default/files/itf-sipa_mng_dissemination_s2_p2_0.pdf, and World Bank. (2020). *Ulaanbaatar Sustainable Urban Transport Project (P174007) - Project Information Document (PID)*.

rising) motorisation levels and resulting congestion, made worse by an ageing vehicle fleet (74% of the fleet at least 10 years old) and low emissions standards (currently equivalent to EURO II/III).

- 2.42 Air quality in Ulaanbaatar is a major public policy issue, which is difficult to solve. While Mongolia has committed to transition to EURO V fuel standards, implementation will depend on availability through fuel supply chains (which is all imported). Mongolia's Ministry of Environment and Tourism (MOET) is strongly supportive of implementation of EURO V standards, as was recently demonstrated with the arrival of 507 new Yutong EURO V buses in early 2024³⁴ (approximately half of the bus fleet in operation in Ulaanbaatar³⁵).
- 2.43 In Ulaanbaatar the city's Draft 2040 Masterplan includes proposals relating to reducing pollution and promoting sustainable mobility in its transport sector:
- Regulations should be placed on used cars such as banning cars over a certain age.
 - Citizens should be able to use public transport services quickly and conveniently and parking needs should be regulated to reduce traffic intensity and congestion.
- 2.44 E-mobility is one of many solutions to reduce transport-related air pollution, and the public policy currently prioritises vehicle and emissions standards and modal shift. Nevertheless, increased ICE vehicle and fuel standards (and costs) will support the relative economic case for EVs.

GHG emission reduction policy

- 2.45 The Ministry of Environment and Tourism's (MOET) Sustainable Development Goals (SDGs) & Climate Change Policy division is responsible for coordinating policymaking related to Mongolia's GHG reduction efforts, Nationally Determined Contributions (NDCs) and other environmental sustainability goals.
- 2.46 Mongolia's revised NDC was submitted in October 2020 and sets out the country's aim to mitigate its GHG emissions by 22.7% by 2030 compared to the business-as-usual scenario. Planned actions within the transportation sector include switching to Euro V fuel standards, switching coal transportation from auto to rail transportation, and switching the heating of passenger trains to electric heating.
- 2.47 While Mongolia's NDC makes no reference to e-mobility, MOET has been actively promoting the development of the sector through both policy proposals (see E-Mobility Assessment) and market development/awareness campaigns with ecosystem

<https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fdocuments1.worldbank.org%2Fcurated%2Fen%2F759651607911151776%2FConcept-Project-Information-Documents-PID-Ulaanbaatar-Sustainable-Urban-Transport-Project-P174007.docx&wdOrigin=BROWSELINK>

³⁴ MUB PTD. (2024). *Response to study team's data request*.

³⁵ Based on 1,093 buses in operation in 2024, according to the MUB PTD (2024).

stakeholders. This includes helping to establish EVAM. However, the absence of explicit policy and justification for e-mobility adoption is a barrier to coordinated action or its implementation in a way that aligns with environmental goals.

Battery recycling

- 2.48 The MRTD is already conscious of the environmental and safety issues presented by end-of-life (ELV) electric vehicles' batteries, detailed further in Battery Reuse and , given the hybrid electric vehicle (HEV) fleet was estimated to be producing 38 tons of high-voltage battery waste annually in 2019³⁶.
- 2.49 Mongolia's "Law on Waste" does include a clause on EV waste, stating that distributors and importers of EVs are responsible for returning ELV batteries them to their manufacturer or to contribute to the construction of domestic recycling facilities. However, no domestic battery recycling facilities currently exist, and the existing legislation does not explicitly explain the process for returning batteries to their manufacturer. While this is not unusual in the context of frontier markets for EVs, the principal import of used (vs new) EVs means the issue will require early consideration, although mass electrification remains a long-term prospect.

CONCLUSION: ENVIRONMENT SECTOR READINESS

Ulaanbaatar's air quality is a major public policy agenda to which transport is a significant (but not main) contributor. E-mobility is, however, only one of a range of solutions, with fuel/vehicle standards and modal shift currently prioritised.

While e-mobility is not explicitly referenced in Mongolia's NDC, there is proactive support by MOET for ecosystem development. Nevertheless, absence of a clear cross-sector strategy frustrates efforts for e-mobility to support environmental and wider public policy goals.

EV battery waste poses significant environment and safety risks, far greater than existing concerns around HEV batteries. Mongolia has no domestic EV battery recycling or clear pathway for return of used EV batteries to manufacturers.

Overall Readiness

- 2.50 Mongolia has a very small but fast-growing EV sector, driven principally by private markets but with an enabling public sector framework of standards, planning (charging infrastructure) and pilots in the public transport sector. EV experience in Mongolia has

³⁶ Capacity Development for Climate Policy in the countries of Southeast, Eastern Europe, the South Caucasus and Central Asia, Phase III. (2022). *SITUATION REPORT: MANAGEMENT OF BATTERIES FROM END-OF-LIFE HYBRID VEHICLES IN MONGOLIA*. https://changing-transport.org/wp-content/uploads/2022_Management_End-of-Live_batteries.pdf

shown the high-level suitability of EV technology in extremely cold winters, although experience from elsewhere shows the need for technology solutions and user education to smooth the transition.

- 2.51 Low energy costs support economic viability of EVs in many market segments. However, mass transition is unlikely in the short-medium term due to poor economics (both TCO and financing for upfront costs) and limited supply of older EVs with specifications suitable for Mongolian winters in the mass market segment (representing 97% of automobiles). Opportunity segments are principally in the high-end automobile sector and light commercial vehicles (both urban taxis and vans), with positive economics and good medium-long term supply prospects.
- 2.52 For urban buses, Mongolia's carbon intensive energy grid means electrification will only have an impact on decarbonisation when supported with renewable energy – either through off-grid provision or with major reforms to the energy governance model and reactivation of grid decarbonisation plans. Using e-buses as a public acceptance catalyst for bus priority measures (e.g. BRT) would, however, provide low carbon public transport and improve e-bus productivity (and therefore economics).
- 2.53 Tensions also exist in the relationship between e-mobility and wider urban mobility policy. Ulaanbaatar is seeking to promote mode shift to address the poor accessibility and congestion which stifle economic growth and quality of life. While electrification of light vehicles does mitigate GHG emissions even on the current grid mix, the reduction in marginal cost of automobile use risks increasing congestion and needs careful management. Care also needs to be taken to consider an 'Avoid-Shift-Improve' hierarchy to transport decarbonisation, and public investment in reducing the need for motorised transport (avoid) and modal shift (shift) may in many cases offer greater value for money than electrification (improve).
- 2.54 In conclusion, e-mobility is a viable option for decarbonisation in Mongolia. Opportunity sectors exist, and market-driven electrification should in general be supported and enabled. However, market-driven growth is likely to be low-moderate over the next 10 years. For public sector initiatives, careful consideration should be given to how any proposal for public investments in EVs supports (and does not conflict with) higher priority public policy in urban mobility and decarbonisation, among others.

Table 2-2: Sector Readiness Summary Table

Sector		Issues	Readiness	Observations
Technology		Extremely cold conditions Sparse population density	Moderate-high readiness in UB Low readiness outside of UB	UB has demonstrated technical feasibility of EVs in the city. EVs not yet feasible outside of UB due to real and perceived vehicle ranges.
Vehicle Market	Economic competitiveness & financial accessibility	Electric mass-market private cars & buses are not currently competitive due to high capital costs Mid-range & new private cars are competitive but not a large segment	High-use light commercial vehicles are ready and are significant segments Other significant segments are currently not ready	Electricity prices are comparatively low in Mongolia, so operating costs are low for EVs. The capital cost of mass-market private electric cars will need to reduce to a much more comparable level to ICE vehicles and HEVs for the TCO to become competitive. Buses could become more competitive if significant bus priority measures are introduced. Electrification of taxi fleet could prove difficult without significant formalisation of the segment.
	Market availability	Private bus operators are unable to afford BEBs with private financing currently available Lack of mass-market, older second-hand private EVs, especially from traditional source nation Japan in the short- to medium-term	Distributors of new private and light commercial vehicles are already established. BEBs have been internationally procured. Distributors such as the Leaf Center have begun importing second-hand private EVs. EV financing for new and used private vehicles is established	Potential for Green Climate Fund to be extended to bus operators. Likely that mass-market private vehicles will shift from Japan to China for used EVs, given China has been the global leader in EV adoption so will have the earliest availability of used EVs, has a shorter supply chain to Mongolia than Japan and drives on the same side as Mongolia.

	Market acceptability	Used Nissan Leafs (more equivalent to a mass-market option) have struggled with driving range in winter	Mid-range and new private EVs with high ranges have been accepted well into the market, with dedicated parking spaces offering opportunities for captive charging	BAIC EU5 has become the preferable private EV for the mass-market, with a range of up to 400km and a relatively affordable upfront cost.
Public Transport		GHG emissions of BEBs and diesel buses are equivalent under current operating conditions & energy mix TCOs of BEBs are higher than diesel buses	No clear rationale for BEBs over EURO V diesel buses in UB at present	Strong bus priority measures and a cleaner energy mix could provide a rationale for BEBs in the medium- to long-term. In the short-term, EURO V diesel buses with strong bus priority measures would better help MUB achieve its goals of affordable mass-transit and improved air quality.
Energy	Electricity generation	High carbon intensity of energy grid means GHG emissions of EVs are higher than in most countries, and even higher than ICE buses in Mongolia for BEBs	Low readiness – 9% of current energy mix is RE, and this is unlikely to increase in the near future, with new coal-powered stations planned for the coming years	Up to 19% of energy is imported from Russia, covering seasonal generation shortages and year-round peak load balancing – RE could help to improve energy security as well as reduce carbon intensity.
	Energy supply	Domestic energy generation doesn't meet existing peak demand Informal ger areas have limited access to electricity	If EV charging demand can be managed to avoid peak times, there is capacity in the grid to support EV charging	There are Time of Use tariffs being used to manage peak demand with plans to expand the number of users in UB using smart meters.
	Economic governance	Single buyer energy model prevents the purchase of RE through the grid RE is more expensive than coal, so CHPPs are preferred	There is an established regulatory framework for the integration of Renewable Energy Source (RES) generation	The introduction of competition to the grid could offer more RE to end-users, but they would likely have to pay a premium for it.

Environment	Air quality & GHG emissions	UB has high GHG emissions and poor air quality Transport sector is a contributing factor, through congestion and low emissions standards	MOET actively promotes e-mobility policies to line ministries as strategies for meeting SDGs and NDCs	E-mobility should be promoted as part of a wider package of measures promoting sustainable urban mobility and a greener energy grid (with the energy sector being a more significant contributor of pollutants).
	EV battery waste	EV battery waste poses an environmental and safety issue	The "Law on Waste" does state used EV batteries should be returned to their manufacturer, but there is no clear guidance on or enforcement of this	In the medium- to long-term, domestic EV battery recycling/repurposing facilities could aid Mongolia's transition to EVs and contribute to the economy.

Vehicle Segment Prioritisation

- 2.55 Within the overall Mongolian EV ecosystem, the maturity of different vehicle and use case segments will affect readiness. This section makes an assessment of key segments to enable the roadmap to prioritise specific opportunity segments and target policy and fiscal incentives to overcome remaining barriers. The process for this is outlined below in Figure 2-7, with Target Setting and modelling outlined in Chapters 3 and 4.

Figure 2-7: Vehicle segment prioritisation approach



Methodological approach

- 2.56 The segments considered in the TCO analysis have been grouped into categories based on their functional similarities in terms of the technology, their financing, and their use, specifically:
- Private Automobiles
 - Light Commercial Vehicles (taxis, vans)
 - Urban buses

Overall readiness considerations

- 2.57 The considerations for the overall readiness for electrification of each of the segments has been split into:
- **Market readiness**, which covers the demand (economic and technical suitability) and supply side (availability) factors. This considers the extent to which an EV-purchaser led market can be expected to develop for each segment, and the extent of barriers and public support requirement to achieve this.

- **Policy support**, which assesses the extent to which each market segment contributes to (or in cases, may conflict with) public policy goals, including GHG emissions, grid impacts, and wider urban mobility goals.

2.58 In the category-level assessments below, each vehicle segment has been scored out of five for both of these categories, as well as a score out of five for supply chain readiness, GHG emissions impact and grid readiness, and urban mobility policy readiness. Each segment is given a total score out of a possible 25. This score, combined with identification of any 'fatal flaws' to EV transition for a particular segment have been used to determine a qualitative "low" to "high" readiness assessment.

Market readiness

- 2.59 For the **economic** considerations, firstly the **Total Cost of Ownership (TCO)** of each segment is compared to its ICE vehicle equivalent, followed by a **future economic feasibility** assessment, based on anticipated trends for each segment. The potential to **finance the upfront capital costs** is the final economic consideration. The overall readiness for electrification of each segment for these three considerations is attributed a score out of five.
- 2.60 For the **technological** considerations, the main concern is the **range** of the vehicles in each segment, which will be largely determined by the distances covered by the vehicles and, particularly in Mongolia, the climatic conditions they operate in. Related to this is the **availability of chargers** and the **ability of chargers to operate** in extremely cold conditions. The readiness of each segment is again given a single score out of five for the three technological considerations.
- 2.61 In terms of **supply**, the availability of EVs in each segment to the Mongolian market was considered both at present and into the near future. A single readiness score out of five was given for this consideration.

Policy support

- 2.62 The current **net GHG impact** of the electrification of each segment is an important consideration to assess the rationale for the electrification of that segment. This assessment is conducted using 2024 data to use the most recent data without introducing the uncertainty of projections. To consider how this may change in the future, an assessment of the **potential for grid-based and off-grid Renewable Energy Sources (RES)** is made. A cleaner energy supply for each segment would strengthen the case for

electrification. These three factors are considered together and given a single score out of five.

- 2.63 For urban policy support, the potential impact of the electrification of the segments on **air quality** and **modal split**, two policy focusses for the GoM and MUB, are considered together and given a single score out of five.

Private Automobiles

- 2.64 Table 2-3 provides an overview of the factors affecting private automobile transition to EVs in the Mongolian context, and their alignment with public policy.

Table 2-3: Assessment of readiness and approach for private automobile segments

	Mass Market	Mid-Range	New
Fleet size (all fuels, stock)	264,709 85% of 2021 registrations	37,371 10-12% of 2021 registrations	9,343 3-5% of 2021 registrations
Market Size (all fuels imports pa)	Total segment imports pa 66,000 in 2022, 75,000 in 2023		
Past Segment Growth rate	4% per annum (5-year average to 2021) - (stock)		
Future Segment Growth rate	2% per annum (UB 2040 Masterplan Projections – 2022-2040) (stock)		
Current EVs	Nissan Leafs	BAIC EU5	BYD, Mercedes, VW, others available
ECONOMIC READINESS	LOW (1)	MEDIUM (3)	HIGH (4)
Current Economic Feasibility (TCO Differential)	EV 6% higher than ICE EV 28% higher than HEV	EV 27% lower than ICE VEHICLE EV 20% lower than HEV	1% higher than ICEV N/A for HEV
Future Economic Feasibility	Uncertain market dynamics as developed economies phase out ICEVs	Expected capex parity as soon as 2028, however potential high competition	Expected capex parity as soon as 2025
Ability to finance upfront cost	Purchasers have low financing capacity, cost sensitive	Moderate financing ability, some cost sensitivity	High financing ability
TECHNOLOGY READINESS	LOW-MEDIUM (2)	MEDIUM (3)	MEDIUM (3)
Range	Limited range in winter (current models) even for urban journeys	Range anxiety for longer journeys	Range anxiety for longer journeys
Charging Technology	Some issues with Fast Charging in winter. However, can be mitigated with user education, charging strategies (overnight, destination), and increased fast charger deployment.		
Charging Availability	Moderate coverage in urban areas, very limited outside of Ulaanbaatar, which contributes to range anxiety		
SUPPLY READINESS	LOW (1)	LOW-MEDIUM (2)	HIGH (5)
Supply Chain	Restricted Constrained by low Japanese EV rates (3% in 2022) in medium term.	Developing Comparably priced used EVs from Korea/China available.	Developed No restrictions on supply chain.
GHG & GRID READINESS	LOW-MODERATE (2)	LOW-MODERATE (2)	LOW-MODERATE (2)

GHG Impact - 2024	46% reduction vs. predominant HEVs	46-54% reduction depending on technology.	54% reduction vs predominant ICEVs.
Potential for grid-based RES market	No RES market via grid.	No RES market via grid.	No RES market via grid.
Potential for off-grid RES	Limited opportunity High-cost relative to grid (1-2x higher)	Limited opportunity High-cost relative to grid (1-2x higher)	Limited opportunity High-cost relative to grid (1-2x higher)
URBAN MOBILITY POLICY READINESS	LOW-MODERATE (2)	LOW-MODERATE (2)	LOW-MODERATE (2)
Air Quality Impact	Significant but limited by low mileage and HEV technology May be offset by EV energy source (urban thermal power plant)	Significant but limited by low mileage and newer emissions technology May be offset by EV energy source (urban thermal power plant)	Significant but limited by low mileage and newer emissions technology May be offset by EV energy source (urban thermal power plant)
Mode Shift Impact	Reduces marginal cost of automobile use.	Reduces marginal cost of automobile use.	Reduces marginal cost of automobile use.
OVERALL READINESS	8/25	12/25	16/25
Readiness	Low	Low-Moderate	Moderate

Summary recommendations

- 2.65 The assessment finds a positive environment for private automobiles to transition to EVs in higher end vehicles in the short/medium term. This will have some positive impact upon GHG emissions and reduce tailpipe pollutant emissions. However, the reliance of the grid upon thermal energy (and location of current and future planned plants within city limits) may reduce these benefits. Reduced marginal cost of vehicle use will also conflict with policy to reduce private automobile use.
- 2.66 Transition to EV in these segments is nevertheless a net benefit, and policy and regulation has the opportunity to enable and, where possible, accelerate this privately led transition without compromising on its commitment to traffic demand management and public transport priority.
- 2.67 Mass market vehicle segments may be attractive for electrification in the longer term, but current technologies for older EVs means poor performance (particularly in winter), while their supply is limited and competes with cheap Japanese ICE vehicle and HEV imports.

Given the prevalence of HEVs in the mass market vehicle segment, the relative benefits of this sector are lower than other vehicle markets. However, small numbers of mass market EVs are already entering the market and recommendations for private automobiles could benefit both higher end and mass market vehicles in practice.

Commercial Vehicles

2.68 Table 2-4 provides an overview of the factors affecting transition of urban commercial light vehicles to EVs in the Mongolian context, specifically focusing on taxis, premium taxis (e.g. transfer services) and light freight vehicles (new vans).

Table 2-4: Assessment of readiness and approach for light commercial vehicle segments

	Taxis (Mass Market)	Private Hire (New vehicles)	Light Urban Freight
Market Size (stock)	Approx. 40,000 ³⁷ (of which approx. 600 formal ³⁸)	Unknown	Approx. 28,000 ³⁹
Past Segment Growth (stock)	Unknown but assumed to be approx. 9% per annum in the 5 years up to 2021 (the last year of available data from NAVC on sedan vehicle registrations).	Unknown	3% per annum (2013-2023 average, excluding anomalous reclassification year) - stock ³⁹
Future Segment Growth	Assumed will grow in line with GDP per capita from 2022.	Assumed will grow in line with GDP per capita from 2022.	Assumed will grow in line with GDP per capita from 2022.

³⁷ Estimate from UB Cab, which makes up the majority of the market.

³⁸ MUB PTD. (2023). Response to study team's data request.

Combination of PTA operated taxis and 8 private taxi operators.

³⁹ Based on NAVC "bus" data, having been informed by NAVC that in 2019 vans became re-classified as "buses", and subtracting estimated bus & minibus figures for that year

Current EVs	No formal taxes are electric (as of 2023) ³⁸ . It is unknown how many informal taxes are EVs (although the fleet is thought to be limited if it exists).	Unknown (although thought to be none given the range constrictions).	BYD T3 is the most commonly imported new Light Urban Freight vehicle, with Wuling EV50 & Ford Transit E-350 also imported but in low numbers (16 total in 2023) ⁹
ECONOMIC READINESS	MODERATE (3)	MODERATE-HIGH (4)	MODERATE-HIGH (4)
Current Economic Feasibility (TCO Differential)	EV 25% lower than ICE EV 20% lower than HEV	EV 15% lower than ICEV N/A ⁴⁰	EV 29% lower than ICEV ⁴¹ N/A ⁴²
Future Economic Feasibility	Despite some risk of reduced used ICEV capital cost, expected to remain lower TCO than ICEV due to high mileage and low Opex	Expected to continue with lower TCO. Capital cost parity by 2025.	Despite some risk of reduced used ICEV capital cost, expected to remain lower TCO than ICEV due to high mileage and low Opex
Ability to finance upfront cost	Low capacity by individual taxi owners, particularly if mid-range vehicle required	Moderate, depending on size of business	Moderate, depending upon size of business
TECHNOLOGY READINESS	MODERATE-HIGH (4)	LOW (1)	MODERATE-HIGH (4)

⁴⁰ New HEV are not commonly sold on the Mongolian market.

⁴¹ New vehicles. Used LCV expected to have similar TCO profile as mass market taxis.

⁴² New HEV are not commonly sold on the Mongolian market.

Range	Urban use only, so limited range anxiety. Mass market vehicle operationally inappropriate due to frequent charging needs, however mid-range EV appropriate with marginal TCO impact.	Vehicles required to travel to remote areas (e.g. for tourism) and intercity journeys. Increased challenges during winter months.	Urban use only, so limited range anxiety subject to opportunity charging during winter.
Charging Technology	Some issues with Fast Charging in winter, however can be mitigated with user education, charging strategies (overnight, destination), and increased fast charger deployment.		
Charging Availability	Moderate coverage in urban areas. Potential for captive charging arrangements.	Limited to non-existent outside of Ulaanbaatar	Captive overnight charging possible at depots. Moderate opportunity charging coverage within Ulaanbaatar for fast charging.
SUPPLY READINESS	MODERATE (3)	HIGH (5)	MODERATE-HIGH (4)
Supply Chain	Mass market vehicles constrained by low Japanese EV rates (3%) however comparable Chinese/Korean mid-range EVs increasingly available.	No restrictions on supply chain.	No restrictions for new vehicles High volumes of used vehicles will become available from Korea (28% sales penetration 2022) and China (5%)

GHG & GRID READINESS	MODERATE (3)	MODERATE (3)	MODERATE-HIGH (4)
GHG Impact	46% reduction vs. predominant HEVs on high daily mileage	54% reduction vs predominant ICEVs on high daily mileage.	54% reduction vs predominant ICEVs on high daily mileage
Potential for grid-based RES market	No RES market via grid.	No RES market via grid.	No RES market via grid.
Potential for off-grid RES	Limited opportunity High-cost relative to grid (1-2x higher)	Limited opportunity High-cost relative to grid (1-2x higher)	Opportunity at depots/garages High-cost relative to grid (1-2x higher)
URBAN MOBILITY & POLICY READINESS	MODERATE (3)	LOW-MODERATE (2)	MODERATE-HIGH (4)
Air Quality	High mileage in urban areas means significant benefits (though relative to HEV) May be offset by EV energy source (urban thermal power plant)	High mileage means significant benefits, though often in non-urban areas so limited impact May be offset by EV energy source (urban thermal power plant)	High mileage in urban areas means significant benefits relative to ICEV vans. May be offset by EV energy source without RES use
Mode Shift	No impact on modal shift	No impact on modal shift	No impact on passenger modal shift.
OVERALL READINESS (pts)	16/25	15/25	20/25
OVERALL READINESS (L-M-H)	Moderate	Moderate	High

Barriers	Financing challenge for taxi operators Availability of opportunity charging and deployment of captive charging	Technology not suitable EV charging infrastructure outside UB	Financing challenge for smaller operators Availability of opportunity charging and deployment of captive charging

Summary recommendations

2.69 The assessment finds that:

- Urban taxis have low potential in the short term, pending the more contextually appropriate technologies of more recent EV generations. However, they are likely to be technically and commercially feasible in the medium-long term (particularly if accompanied by institutional and governance changes in the taxis sector).
- Light goods vehicles (vans) show strong potential in the short term for deployment within the urban freight sector and planned initiatives. Vans are predominantly used for last mile logistics in urban settings (such as urban deliveries, courier and parcel services), with current e-van operator reporting daily usage of under 200km/day (within the range of a single charge). Ulaanbaatar's 2040 Development Masterplan prioritises further shifts for urban freight towards vans to mitigate the impacts of heavy trucks (particularly in the city's commercial core).
- Private hire vehicles are not suitable to take forward since the requirement for them to be able to travel to remote rural areas limits their technical feasibility.

Urban Buses

2.70 Table 2-5 provides an overview of the factors affecting transition of the urban bus sector to EVs. The analysis has highlighted two critical challenges in relation to the deployment of battery electric buses, specifically:

- **Low capital productivity of the current fleet**, owing to low speeds in mixed traffic operation and suboptimal charging strategies. Sensitivity analysis found that by achieving a 20% increase in daily service kilometres, the differential in TCO per km could be reduced from 12% to 2%, making BEB more financially viable.

- **Negligible GHG mitigation impact** when charged using the current grid energy mix and factoring in emissions from diesel heating in winter. This would weaken the case for BEBs, particularly in relation to climate financing. Provision of off-grid renewable energy for e-bus charging would address this barrier, requiring investment understood to be equivalent to US\$0.08-10/kWh, in increasing the TCO gap from 12% to 23%.

Battery Electric Bus deployment options

2.71 Having identified these two issues, the opportunity assessment considers three further options for urban bus electrification to assess scenarios in which BEB may be appropriate and feasible in the context of Ulaanbaatar.

- 1) **'Current Model'**: This assumes expansion of the current approach to BEBs, with vehicles operating predominantly in mixed traffic and charged through grid-connected depot charging located off route.
- 2) **'Optimised Operation'**: This assumes an approach of implementing BEBs with a 20% increase in fleet productivity (km per day), which could be achieved through improved charging strategies (e.g. opportunity charging on route) and increased bus speeds through dedicated BEB lane (e.g. Green Corridor) interventions. In this context, reduced air pollution and sustainable transport investment would be assumed to strengthen public support for enforced road space reallocation towards public transport compared to existing diesel buses.
- 3) **'Green Energy'**: This assumes an approach through which BEBs would be charged using a captive renewable energy system to enable them to provide carbon mitigation benefits. This would increase energy costs from \$0.04/kWh to \$0.10kWh (in line with local cost estimates). The BEBs would continue to operate as in the base model (i.e. mixed traffic running and off-route opportunity charging).
- 4) **Combined Optimised Operation + Green Energy**: This option would combine options 2 and 3, resulting in increased bus operating efficiency and providing carbon mitigation benefits.

Table 2-5: Battery Electric Bus deployment options

	1. Urban Buses (Current Model)	2. Urban Buses (Optimised Operation)	3. Urban Buses (Green Energy)	4. Urban Buses (Optimised Ops+ Green Energy)

Market Size (vehicle imports)	110 per year			
Growth Rate	Growth is in line with urban public transport policy			
Current EVs	55 pilot e-buses ³⁸			
ECONOMIC READINESS	2	4	1	2
Current Economic Feasibility (TCO Differential) – In Service	EV 30% higher than ICE	EV 14% higher than ICE	EV 50% higher than ICE	EV 33% higher than ICE
Future Economic Feasibility	Unlikely to achieve TCO parity with ICEV in medium-long term	TCO parity likely in medium term	Unlikely to achieve TCO parity with ICEV in medium-long term	TCO parity may be possible in long term ⁴³ in line with reduced RES costs
Financing ability	Only through public financing	Only through public financing	Only through public financing	Only through public financing
TECHNOLOGY READINESS	4	4	4	4
Range	No issues subject to adequate charging strategy			
Charging Technology	Service planning requires consideration for winter performance			
Charging Availability	Captive charging used. Requires deployment of efficient charging strategy for opportunity charging.			
SUPPLY READINESS	5	5	5	5
Supply Chain	No issues	No issues	No issues	No issues
GHG & GRID READINESS	1	1	5	5
GHG Impact	No change	No change	Up to 100% reduction (excl. heating)	Up to 100% reduction (excl. heating)
Potential for grid-based RES market	No RES market via grid.	No RES market via grid.	No RES market via grid.	No RES market via grid.
Potential for off-grid RES	Not included in this option	Not included in this option	Depot based RES provision possible, at high-cost premium	Depot based RES provision possible, at high-cost premium.

⁴³ Relative also to reductions in the cost of renewable generation.

URBAN MOBILITY & POLICY READINESS	2	4	3	5
Air Quality	High impact at tailpipe. Contributes to grid energy demand (urban thermal supply)	High impact at tailpipe. Contributes to grid energy demand (urban thermal supply)	High impact at tailpipe and reduced grid energy demand.	High impact at tailpipe and energy source
Mode Shift	No impact on modal shift	Substantial impact to promote modal shift	No impact on passenger modal shift.	Substantial impact to promote modal shift
PT System performance	No impact on PT system performance	Improved PT system performance	No impact on PT system performance	Improved PT system performance
OVERALL READINESS (pts)	14	18	18	21
OVERALL READINESS (L-M-H)	Moderate	Moderate-High	Moderate-High	High
Engagement Feedback	Unclear justification for e-bus transition using the current model. Recent focus on EURO V Diesel and mode shift	Reducing the cost of e-bus transition would reduce barriers. Achieving bus priority to increase bus speeds has been challenging.	Meeting energy demand without major grid impact is positive. No clear transport sector benefits	Cost and affordability important.
Readiness	Technically deliverable, but high costs and limited tangible benefits.	Aligns e-mobility with wider public transport priority if e-buses increase political acceptability of bus priority (e.g. green corridor). Decarbonisation impact would be through modal shift impacts.	Technically deliverable. Limited policy and political support: Addresses RES (not a primary urban mobility goal) and increases costs without improving performance.	Technically deliverable. Strengthens technical case for option 2. Strengthens case for 'green corridor' approach to bus priority
Recommended Approach	No clear justification	Appropriate option if Option 4 not affordable.	No clear justification	Recommended approach

Summary recommendations

- 2.72 There is no clear justification for a wider scale-up of BEBs in Ulaanbaatar based on the current charging and operating model. The charging of BEBs using the current grid mix results in negligible (to even negative) impacts upon GHG emissions and reduces their operating productivity (vs diesel buses). There are no significant user benefits (e.g. improved accessibility) vis-à-vis modern diesel buses, while the air quality benefits at tailpipe have to be seen in the context of increasing demand for energy in UB, for which expansion of thermal energy remains the preferred option (potentially within the city limits). In this context, there is unlikely to be a justification for additional investment cost in BEBs versus other options for urban transport decarbonisation.
- 2.73 Other options may however provide the basis for BEBs to support transport decarbonisation and other policy goals in Ulaanbaatar:
- If investment in BEBs can be used as a catalyst for more efficient operation, this would create a strong case for further expansion. On the cost side, this would reduce the TCO of BEBs, bringing them closer to parity with diesel buses. The benefits case for use of BEBs can be strengthened if their introduction can support implementation (and robust enforcement) of bus priority measures (such as a Green Corridor approach). In this scenario, benefits will accrue from improved accessibility. Decarbonisation would occur not from technology change (which would remain similar), but from improving public transport journey times relative to private vehicles which would in turn promote modal shift from more energy intensive modes (e.g. private cars). For example, in Bogota, Colombia, the use of BEBs to increase the public and political support has been critical to current implementation of the Seventh Avenue Green Corridor BRT in Bogota, Colombia⁴⁴, following at least 20 years of opposition.
 - **Use of RES for BEB charging** would support the case for a Green Corridor-type approach, in demonstrating zero emissions at both the tailpipe and energy source. It would, however, offset some of the TCO savings achieved through the operational efficiencies (although it could also potentially open up climate financing options) which would need to be assessed based on the project. RES charging for BEBs in the existing operating model is unlikely to offer value for money relative to mode-shift based approaches and would add to the financial deficit of the bus operation.

⁴⁴ ¿Transmilenio por la séptima?: verdades y mentiras del corredor verde de Claudia López. (2020, November 24). RTVC. <https://www.canalinstitucional.tv/noticias/corredor-verde-septima-claudia-lopez-transmilenio>

Conclusions

2.74 Table 2-6 summarises the scoring of each segment to take forward into the scenario analysis, along with any ‘fatal flaws’ which make the segments unviable for EV adoption, regardless of their overall readiness score. Recommendations are summarised in Table 2-7.

Table 2-6: Summary of segment readiness for electrification

	Private Cars			Commercial			Urban Buses			
	Mass Market	Mid-range	New	Mass Market Taxi	Premium Taxi	Light Commercial Vehicle	Current Model	Optimised Operation	Green Energy	Opt. Ops+ Green Energy
Economic Readiness	1	3	4	3	4	4	2	4	1	2
Technology Readiness	2	3	3	4	1	4	4	4	4	4
Supply Readiness	1	2	5	3	5	4	5	5	5	5
GHG & Grid Readiness	2	2	2	3	3	4	1	1	5	5
Urban Mobility Policy Readiness	2	2	2	3	2	4	2	4	3	5
Market Readiness	4	8	12	10	10	12	11	13	10	11
	Low	Moderate	Very High	High	High	Very High	Very High	Very High	High	Very High
Policy Support	4	4	4	6	5	8	3	5	8	10
	Low	Low	Low	Moderate	Low-Moderate	High	Low	Low-Moderate	High	Very High

Overall Readiness	8	12	16	16	15	20	14	18	18	21
Low/Moderate/High	Low	Low-Moderate	Moderate	Moderate	Moderate	High	Moderate	Moderate-High	Moderate-High	High
Fatal Flaws	TCO Supply				Technology		GHG Impact	GHG Impact	TCO	
Approach	Enable*	Enable	Enable	Enable & Promote		Enable & Promote				Enable & Promote

* Recognising that small numbers of mass market EV automobiles are already in operation and are likely to develop, albeit at a slow pace, and that recommendations for private automobiles likely could apply to all segments within this category. The enabling approach will focus on market-shaping rather than significant financial investments.

Table 2-7: Vehicle segment recommendations

Segment	Recommendation	Segments to take forward
Private Automobiles ENABLE	- Develop an enabling environment (e.g. charging, supply chain) for EV transition for necessary private vehicle journeys while prioritising modal shift towards sustainable transport. - Initial focus on newer vehicle segments in the short term (to 2030), with mass market models becoming more economically and technically competitive towards 2035. - Based on engagement feedback, EVs are not considered feasible for areas outside of UB in medium term (requirement to cover long distances in remote environments)	Vehicles up to 3 years upon import (new, mid-range) Vehicles over 3 years upon import (mass market).
Light commercial vehicles ENABLE & PROMOTE	- Promote further deployment of light freight vehicles (vans) for urban use - Urban mass-market taxis will become more appropriate in the medium-long term as technology improves and with governance reform of the sector.	Light commercial vehicles (vans) Taxi (mass market)
Urban buses ENABLE & PROMOTE	Promote urban BEBs are an appropriate option only as part of wider package of operational improvements (with or without RES adoption).	Urban buses (Optimisation + Green Energy).

3. E-Mobility Development Vision & Scenarios

Introduction

- 3.1 This section develops and quantifies potential EV development scenarios for high readiness segments identified in the E-Mobility Assessment and outlined in Chapter 0. The study team developed three specific development scenarios. They are:
- Base Case scenario -representing current plans and policies,
 - EV enabling scenario - focused on policy support to enable market-based growth),
 - EV proactive scenario (in which more robust policy and/or fiscal measures are taken to promote accelerated uptake in high readiness segments).
- 3.2 The scenario timelines are 2030 and 2035. Mongolia's very early stages of EV development and the highly dynamic global and regional EV market present major barriers to longer term forecasting. However, these two target years provide a period which allows for prioritisation of clear short-term measures and a horizon considering medium term trends and opportunities.

Vision Building

- 3.3 The overall scale of vision for e-mobility should be driven by the potential of e-mobility to contribute to decarbonisation and other public policy objectives. As demonstrated in Chapter 0, for many segments there are significant user and wider social benefits to EV transition which can be achieved at relatively low economic cost.
- 3.4 Nevertheless, in the case of Mongolia, the strategic potential for e-mobility is limited in both absolute and relative terms. Decarbonisation impact is limited by the high grid carbon intensity (now and in the medium-long term) and contribution of urban CHPP to air quality issues, together with other policy priorities to address these (sustainable urban mobility, vehicle emission standards, domestic heating) which offer greater co-benefits or value for money. Unlike many other countries actively promoting EVs, Mongolia does not have either an existing industrial base or ambitions to develop an EV-related industry.
- 3.5 Based on this potential, the Government of Mongolia's vision for e-mobility in this early stage should be developed with an approach to:
- **Enable a private sector led EV transition in high readiness segments**, ensuring alignment with other mobility priorities (e.g. modal shift) through a supportive policy and regulatory framework, level fiscal playing field for EV purchase,

catalysing an EV charging industry, and ensuring an enabling energy sector approach.

- **Catalyse the growth of high-readiness EV sectors** where this can contribute to decarbonisation and/or other public policy goals (e.g. public transport improvement, growth of renewable energy in EV charging). In addition to an enabling environment, implementation of pathfinder projects in the e-bus and light commercial vehicle segments should in particular focus on developing the business models which enable long term economic and institutional feasibility.

Scenario Development and Quantification

- 3.6 The growth of e-mobility in Mongolia will depend upon consumer demand, global supply trends and supportive public policy.
- 3.7 In terms of consumer demand, the key factors will be:
- Economic attractiveness (current and future) of EVs in the Mongolian market (both in terms of feasibility of upfront capex and TCO perspectives) both in 2024 and projected future trends.
 - Technical acceptability of EVs for different vehicle types and use cases in Mongolia considering factors such as range and reliability.
- 3.8 In terms of global supply factors, key factors will include:
- EV penetration in key vehicle trade markets for Mongolia. In used vehicle segments, this penetration will influence future ICE and EV availability and relative costings in the market. For new vehicles, trends from neighbouring countries are likely to influence higher end vehicle purchase decisions.
 - Wider vehicle market dynamics, particularly neighbouring China. China's new vehicle exports have grown exponentially in recent years (both EV and ICE vehicle). Of perhaps greatest significance to Mongolia, China has, since 2019, begun to permit official used vehicle exports⁴⁵, with the potential to shift Japan's dominance in this field.
- 3.9 In considering the public policy environment, the scenarios consider:
- A **Base Scenario**, in which EV growth is left solely to market dynamics under the current regulatory and policy framework.

⁴⁵ The State Council of The People's Republic of China. (2022). *China expands second-hand car exports*. https://english.www.gov.cn/statecouncil/ministries/202212/06/content_WS638ef362c6d0a757729e4043.html#:~:text=China%20officially%20kicked%20off%20the.first%20ten%20months%20of%202022.

- A **Do Minimum (Enabling)** scenario, with a public sector focus on largely non-fiscal interventions to catalyse market development in vehicle segments which are nearing readiness. The targets in this scenario consider:
 - A moderate increase in private automobile EVs, based on existing market demand and the net environmental benefits and readiness of the new vehicle market in particular.
 - A moderate increase in e-vans, given their strong potential for adoption in the short-term with market-based solutions and limited fiscal input from the government.
 - A **Proactive** scenario, in which the Mongolian public sector takes a more robust role to support the development of the EV sector. This includes greater involvement in the development on segments which show readiness and potential to contribute to public policy goals but need more support to make them viable. The targets in this scenario consider:
 - A more substantial increase in private automobiles EVs, reflecting their potential for greater GHG emissions in this scenario.
 - A substantial increase in e-buses (50% bus sales/year by 2035), with a case created through an e-bus corridor & RE-supported charging.
 - A market of urban e-taxis created, alongside the formalisation of the segment, given the environmental case for high-use vehicles if incentives can be distributed to formal operators.
 - A moderate increase in e-vans. The segment has high readiness given the environmental case for high-use vehicles and the ability to distribute amongst fleet operators, however Mongolia remains in early piloting stage for e-vans, and time will be required for mass market acceptance.
- 3.10 Demand-side recommendations in the **Enabling** scenario include giving residents the right to install EV chargers in communal residential parking lots and supporting Charging-as-a-Service (CaaS) service models. Supply-side recommendations include promoting cold weather EV performance optimisation practices and strengthening EV charger planning and implementation in UB and the surrounding region, in coordination with the private sector.
- 3.11 In the **Proactive** scenario, demand-side recommendations include implementing e-bus only corridors and encouraging banks to finance EVs. Supply-side recommendations include encouraging second life uses for used EV batteries and piloting the roll-out of captive RE integration for public transport e-buses.

Sales share forecasting

- 3.12 Table 3-1 summarises the key drivers for future EV targets under each scenario. Demand drivers (Economic Readiness and Technology Acceptability) are the principal determinant of potential penetration (subject to the proposed incentives of each scenario) as indicated above. These assessments are taken from the readiness assessment conducted in Deliverable 1.
- 3.13 Supply availability is also an important factor both to meeting demand (used vehicle segments) and to understand the potential magnitude of global market shifts. This includes how EV supply might shift with increased Chinese market penetration (new and used), or how continued Japanese ICE and HEV technology for new vehicles in 2022 may impact used vehicle markets in 2030. EV sales for these countries are sourced from the International Energy Agency.
- 3.14 Final target setting has taken a professional judgement view of the above demand and supply factors to propose what are believed to be realistic future scenarios, recognising the degree of uncertainty in a rapidly developing market and technology sector.
- Overall:
- **Newer private automobiles** are expected to continue having the highest level of deployment, with rapid growth reflecting their higher existing readiness and penetration of Chinese EV manufacturers into this trend-driven market. Given China's 2030 target of 62% of vehicles being EV, a target of 10% in 2030 and 20-25% in 2035 balances the probably strong supply and demand contexts with Mongolia's ecosystem development which will still lag behind.
 - **Older private automobiles** are forecast to have far lower penetration on account of the lag time between production and deployment in Mongolia (assumed to be on average 8 years) which affects supply. As such, growth of the segment will accelerate as the used EV sector becomes more mainstream in the early 2030s. Nevertheless, uptake in Mongolia will be limited by the profile of consumers, who are typically far more cost sensitive and have lower access to financing for capital costs (even where TCO is positive). Finally, as EV mandates in developed economies take effect, it is possible (even likely) that the value of used ICE vehicles will fall significantly, potentially resulting in a fall in capital cost in the Mongolian mass market vehicle segment.
 - **Vans** are assumed to grow to 10% and 20% in 2030 and 2035 respectively, with a strong existing supply in main import markets for this segment (China and Korea) and positive TCO case. Given that this segment is starting from near zero, further pathfinder pilots and business models would be required to catalyse a market.

- **Urban buses** have a moderate readiness in the current context, however their penetration rates are within the control of MUB and other public stakeholders. At the current time there is no clear justification for their implementation, but subject to energy and business model revisions a realistic and feasible case can be made for their implementation as part of sustainable mobility reforms with 30% and 50% of fleet sales by 2030/2035 respectively.
- **Urban taxis** have a high readiness but face institutional challenges which make EV financing challenging for operators, particularly considering the need to replace mass market HEV with mid-range EVs to mitigate range challenges in local conditions. Without proactive support for this transition, it is unlikely that the sector will see EV transition in any significant form to 2035. However, with proactive support to form business models (e.g. leasing) and coordinate investment, together with wider licensing and regulation reforms, a sales penetration of 10% and 20% by 2030/2035 is considered feasible (initially focused on higher end urban taxis part of formal fleets, before transitioning to mass market urban taxis which are currently largely informal).

Table 3-1: Scenario sales targets and rationale

Segment	Demand Drivers		Supply Availability from Key Markets		Do Nothing Sales %			Enabling Sales %			Proactive Sales %		
	Economic Readiness	Technical Acceptability	% EV sales	Supply Trends	2023	2030	2035	2023	2030	2035	2023	2030	2035
Private cars – up to 3 years on import	Moderate-High: TCO parity met, financing available	Moderate-High: For urban/regional use. Issues for long range journeys.	2030: JP: 20 CN: 62 KR: 32	No EV supply issues, so sales will be market driven. Assumption of increased Chinese EV penetration.	0.7	1.4	1.9	0.7	10.0	20.0	0.7	10.0	25.0
Private cars – over 3 years on import	Low: TCO 28 higher than HEV, financing challenge	Low-Moderate: Performance issues on older EVs, over time may evolve.	2022: JP: 3 CN: 29 KO: 9	Supply constraint in 2030 from Japan. Possible lower global demand for used HEV/ICE. Growth in Chinese used EV export market.	0.7	1.4	1.9	0.7	2.0	5.0	0.7	5.0	15.0
Vans	Moderate: TCO positive, financing challenge for upfront cost.	High: Suitable for urban use, exempt from UB used restrictions.	2022: KO: 27 CN: 14	High uptake in Korea (main current import market) will provide sufficient supply.	0.0	0.0	0.0	0.0	10.0	20.0	0.0	10.0	20.0

E-Mobility Roadmap

Urban Bus	Low-Moderate: TCO much higher than ICE, but battery cost falling.	Moderate-High: Where carbon intensity of charging addressed.	2030: CN: 49 KO: n/a	No EV supply issues for BEBs, so sale will be market driven unless proactively supported by the government.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	30.0	50.0
Taxi (mass market ICE vs mid-range EV)	Moderate-High: EV TCO is positive, though support required to overcome financing requirements.	High: Range suitable for urban use. Exempt from circulation restrictions.	2022: JP: 3 CN: 29 KO: 9	While limited supply from Japan (traditional market), strong availability from China of mid-range vehicles with competitive TCO.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0	20.0

4. Modelling Outputs

- 4.1 To identify the impacts of the EV scenarios, this section provides modelling of vehicle stock growth, required EV charging infrastructure, and impacts on energy demand, fuel consumption, GHG emissions, air pollution and associated benefits. Modelling covers the short- to medium- term roadmap period of 2022-2035 using the Integrated Energy and Transport E-mobility Model (IETEM©)⁴⁶. Modelling covers EV transition for Ulaanbaatar (in which EVs will be almost exclusively located), representing 61.5% of total vehicles registered across the country.

Vehicle Stock Projections

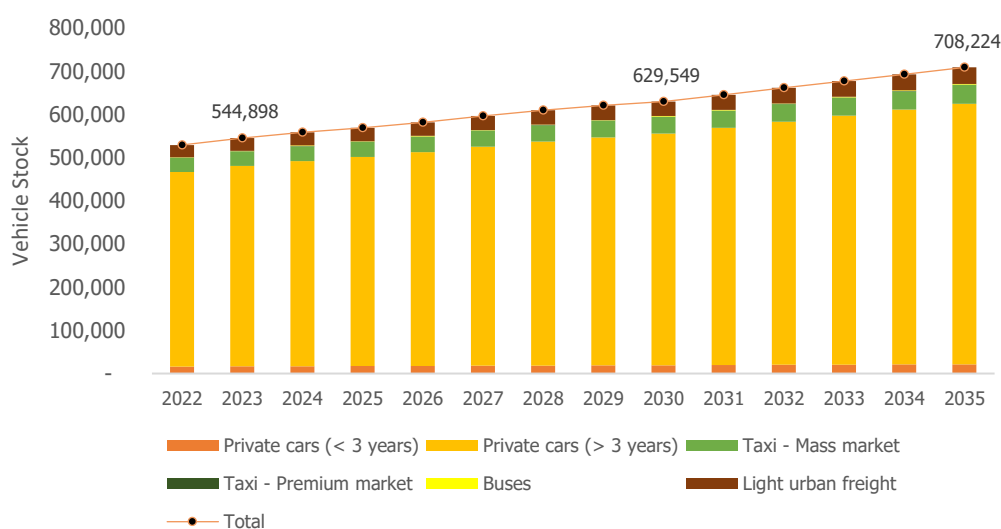
- 4.2 To develop the baseline vehicle stock projection, vehicle registration numbers for both Ulaanbaatar and Mongolia were obtained from NAVC for the years 2010 to 2021. The vehicle stock break-up was available by vehicle type, age, wheel position, engine capacity, etc. Since the data disaggregation was not available for all vehicle segments, the following assumptions we made based on past engagement:
- **Urban taxis:** While there are 600 formal registered taxis in Ulaanbaatar, a far greater number of informal rideshare vehicles exist, understood through stakeholder engagement to be approximately 40,000 (e.g. UBCab app). Of these, 80% are assumed to be located in Ulaanbaatar. Formal taxis tend to be purchased new and of a higher specification than rideshare (typically use mass market automobiles), so are considered 'premium taxis', while the remainder are mass market taxis. All are taken as a subset of private automobile data.
 - **Private cars:** Remaining automobiles are assumed to be private cars, with 97% assumed to be > 3 years upon import (mass market) and the remainder new or mid-range segments.
 - **Buses and light urban freight (vans):** During 2019-2021, light vans were reclassified as 'buses', with a large spike in stock data (as reported by the National Road Transport Centre (NRTC)). As a result, the bus stock moved up approx. 34,000 in 2021 from 6,500 in 2019. It is assumed that this increase of nearly 27,500 vehicles are light freight vehicles, and this figure is used as a baseline. While the remaining 6,500 are assumed to be buses, this study focused on electrification of urban buses within the Ulaanbaatar public transport system, which currently

⁴⁶ IETEM© is an integrated modelling and simulation tool developed by pManifold to analyse different EV adoption scenarios and their impact on grid, environment, Govt. budget and other cross-sectoral considerations for holistic design of National and sub-National e-Mobility policy and roadmap.

number 1,000 buses in operation. Other buses, understood to be private minibuses/microbuses are not included.

- 4.3 From this baseline, the GDP per capita growth rate was applied to forecast vehicle stock trend for the years 2022-2035, with segment-by-segment stock growth for Ulaanbaatar shown in Figure 4-1. This vehicle stock projection is used across all the three scenarios, with the EV penetration assumptions being the principal difference.

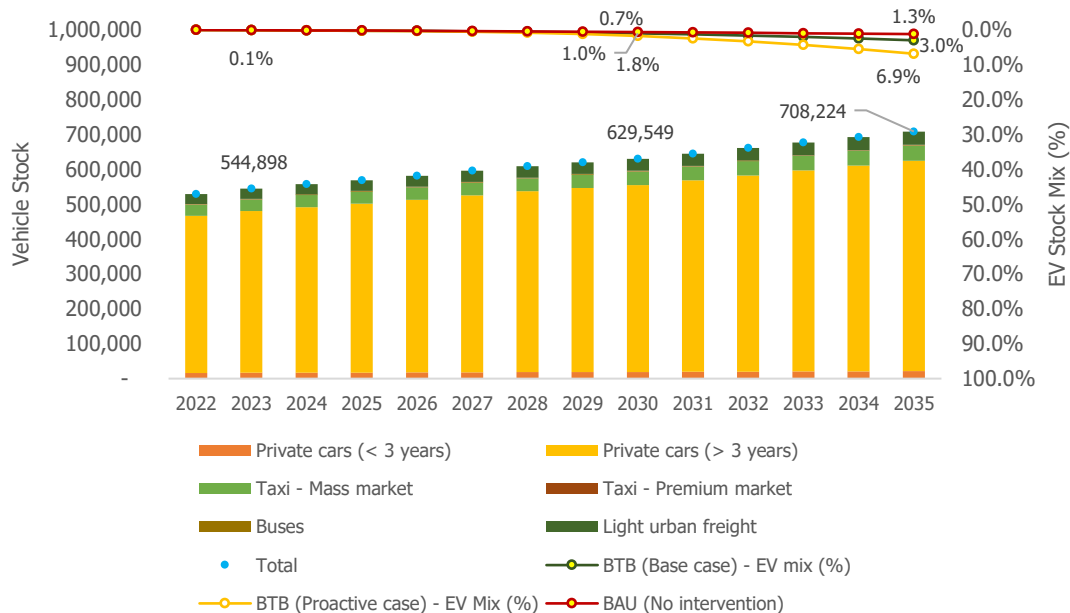
Figure 4-1: Ulaanbaatar vehicle stock growth trend by 2035



EV Stock and Sales Growth Projections

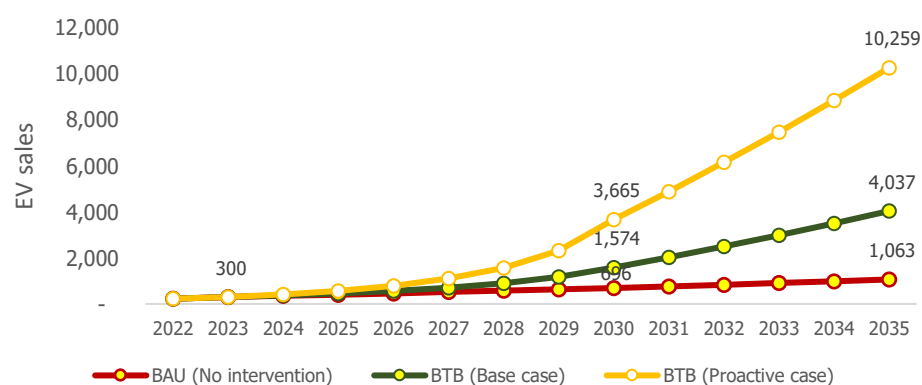
- 4.4 The estimated EV mix as a percentage of total vehicle stock is shown in Figure 4-2. The modelling estimates that EV stock will account for approx. 9,000 units (1.3 percent), 21,500 units (3.0 percent) and 49,000 units (6.9 percent) of total vehicle stock by 2035 for Business-As-Usual (BAU - no intervention), Business-To-Be (BTB - Base case) and BTB (Proactive case) respectively. For BTB cases, more than 70 percent of this EV stock is expected after 2030, as the market for used EVs develops, and pilot deployments mature to wider adoption. In all cases, there is major growth from the current level of EVs in operation in Mongolia.

Figure 4-2: Vehicle Stock vs EV Stock Mix (%) trend across all three scenarios



- 4.5 To analyse annual sales across six vehicle segments, vehicle import data was accessed from MSM (except buses). Based on the analysis of import volumes, the estimated annual sales in Ulaanbaatar are approx. 55,000 units and 61,000 units in 2030 and 2035 respectively. Based on the scenarios defined earlier, the estimated EV sales trend across three scenarios are shown in Figure 4-3.

Figure 4-3: Estimated EV sales across all the three scenarios

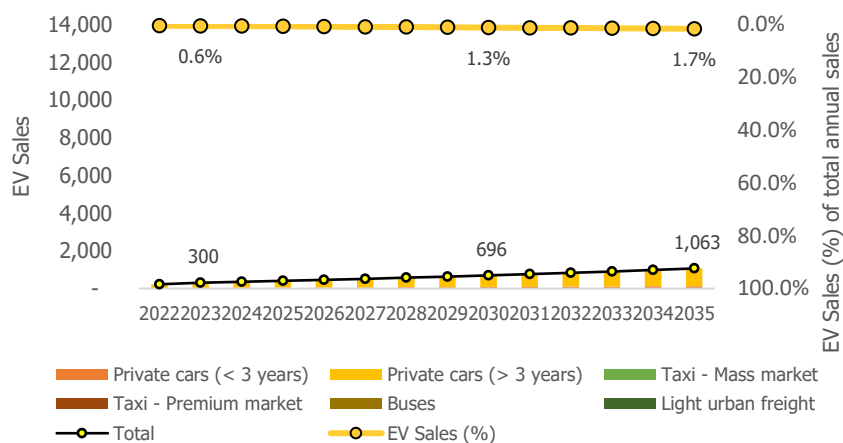


- 4.6 In the BAU (No intervention) scenario, the estimated EV sales in 2035 number approximately 1,050 units (i.e. 1.7 percent of annual sales), reflecting growth driven solely by market forces. The two developed scenarios, while pragmatic and realistic in scale, would achieve EV sales in the range of 4 to 10X of BAU, with EV sales of over 4,000 units (6.6%) and 10,000 units (16.7%) by 2035 (for Enabling and Proactive scenarios respectively). The majority sales volume (~90 percent) would be driven by

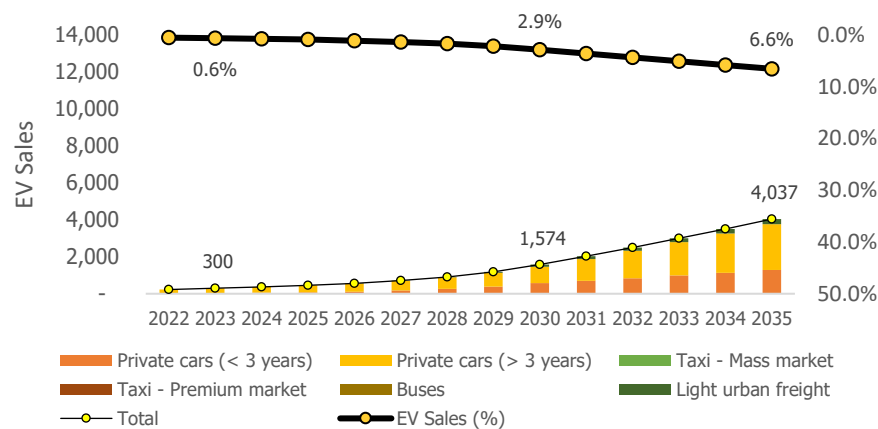
private cars and out of this, private cars (> 3 years) would account for more than 80 percent. The EV sales by vehicle segment-wise across three scenarios is given below.

Figure 4-4: Estimated EV sales by vehicle segment across all the three scenarios

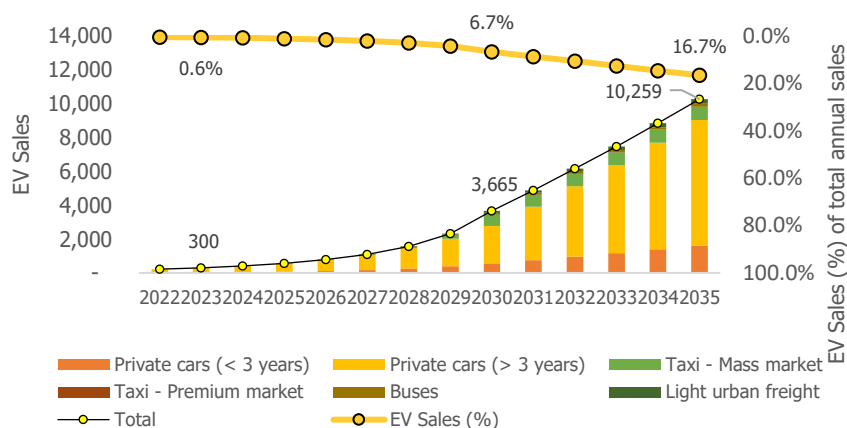
BAU (No Intervention)



BTB (Base case)



BTB (Proactive case)



4.7 The summary of the EV stock and EV sales is given below.

Table 4-1: Summary of EV stock and EV sales

Approx (figures)	2023	2030	2035
EV stock and EV stock mix (as percentage of total vehicle stock)			
BAU (No intervention)	750 (0.1%)	4,400 (0.7%)	9,000 (1.3%)
BTB (Base case)	750 (0.1%)	6,500 (1.0%)	21,500 (3.0%)
BTB (Proactive case)	750 (0.1%)	11,000 (1.8%)	49,000 (6.9%)
EV sales and EV sales (as percentage of total annual vehicle sales)			
BAU (No intervention)	300 (0.6%)	700 (1.3%)	1,050 (1.7%)
BTB (Base case)	300 (0.6%)	1,600 (2.9%)	4,000 (6.6%)
BTB (Proactive case)	300 (0.6%)	3,700 (6.7%)	10,000 (16.7%)

4.8 The above table indicate that EV vehicle stock can be in the range of 2 to 5X from BAU estimates for proposed EV targets. This would have direct impact on GHG and other emissions that are discussed in subsequent sections.

EV Charging Infrastructure Assessment

4.9 This section identifies the number and type of EV chargers required to support the EV growth scenarios, considering home, dedicated/captive and public charging locations. Each vehicle segment would have different preferences for charging locations and charger rating (in kW) would also differ. For charger rating, it is assumed that public chargers would take approx. 1 hour for full-charge, dedicated/captive – 2 hours, and home – 6 hours.

Charging preferences

- 4.10 The charging location by vehicle segment is shown in below in Table 4-2. This shows the proportion of users for each EV segment using each charging type, enabling quantification of EV charger needs. In the case of private cars, all owners are assumed to have home charging as the principal charging mode, with 25% also using public charging points as a secondary 'top up' mode.

Table 4-2: Charging preference across location by vehicle segment

Vehicle segment	Public charging	Dedicated/ Captive charging	Home charging
Private cars (< 3 years)	25% ⁴⁷	0%	100%
Private cars (> 3 years)	25% ⁴⁷	0%	100%
Taxi – Mass market	80%	20%	0%
Taxi – Premium market	80%	20%	0%
Buses	0%	100%	0%
Light urban freight	100%	0%	0%

Charging ratios

- 4.11 Based on preferences, the Mongolian context, and international experience, the number of chargers is quantified using an EV to charger ratio. This ratio differs across charging location and vehicle segment (so, for example, 1 public charger per 40 EVs). This ratio is assumed to be higher than in the US or Norway because of the high rate of private automobiles, home charging and dense compact nature of Ulaanbaatar. It is assumed that no dedicated/captive charger is required for private cars. The EVs to charger ratio (at vehicle stock level) used for modelling across different vehicle segment is summarized in Table 4-3.

Table 4-3: EV to charger ratio

Vehicle segment	Public charging	Dedicated/ Captive charging	Home charging
Private cars (< 3 years)	40.0	0.0	1.0

⁴⁷ A subset of home charging, using public charging as a secondary 'top up' charging option

Private cars (> 3 years)	40.0	0.0	1.0
Taxi – Mass market	12.5	40.0	0.0
Taxi – Premium market	12.5	40.0	0.0
Buses	0.0	4.0	0.0
Light urban freight	8.0	0.0	0.0

- 4.12 The above assumptions are based on the past experience across multiple projects, benchmarks, and stakeholder consultations with the industry experts. Similarly for taxis, it is expected that they are most likely to use public charging stations for charging (80 percent) and some may use dedicated charging stations (20 percent). In such a case, it is assumed that one public charger can accommodate about 12.5 electric taxis (daily travel requirement is 3X greater than private cars) and one dedicated/captive charger can support 40 electric taxis. Similarly, it is assumed that buses will use only dedicated charging infrastructure (100 percent) for buses, whereas light urban freight vehicles will use only public charging (100 percent). The EVs to charger ratio assumed for buses and light urban freight is 4 and 8 respectively.

EV charging infrastructure needs

- 4.13 Based on the above assumptions, the estimated number of charger stock across different locations across all three scenarios in 2035 is given in Table 4-4 below.

Table 4-4: Estimated number of charger stock across different locations in all three scenarios in 2035

Approx (figures)	Public charging	Dedicated/Captive charging	Home charging	Total
BAU (No intervention)	225 (2%)	<15	8,900 (98%)	9,125
BTB (Base case)	700 (3%)	<15	20,300 (97%)	21,000
BTB (Proactive case)	1,600 (4%)	300 (1%)	42,000 (95%)	43,900

- 4.14 It is estimated that more than 95% charger stock would be home chargers (Level 2) due to the high proportion of private automobiles in the EV mix. Demand for dedicated/captive chargers (Level 3) relates principally to e-buses, proposed within the Proactive case. Similarly, the demand for public charger (Level 3) will grow as the demand for electric light urban freights, taxis, and private cars increases.

For public charging infrastructure, the effective EVs to charger ratio is about 30 which is in-line to global trend and estimate. Based on the past experience, this ratio could be low (< 10) during early stage of deployment since there is a need to strengthen

charging network despite low EV stock. As market grows, the charging infrastructure usage is optimised and this EVs to charger ratio improves.

Energy demand impacts

- 4.15 The total energy demand is calculated by multiplying a) EV stock – segment wise, b) Annual vehicle kilometer travelled (VKT), and c) vehicle efficiency (kWh/100km). The EV stock is projected based on GDP per capita method and scenario type (no intervention, base case, and proactive case) as discussed earlier in this section. The other common assumptions used for analysis are listed in Table 4-5.

Table 4-5: Key energy demand assumptions

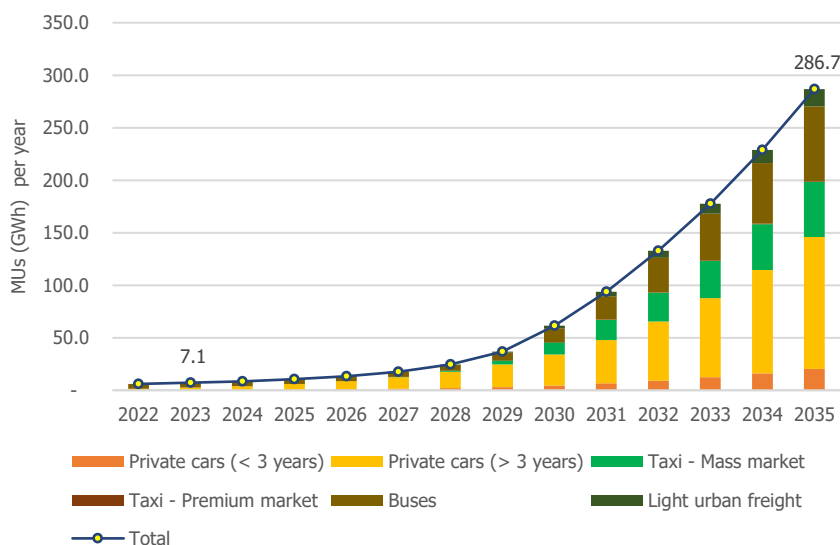
Vehicle segment	Annual VKT (kms/year) ⁴⁸	Vehicle efficiency (kWh/100km)
Private cars (< 3 years)	15,500	16
Private cars (> 3 years)	15,500	22
Taxi- Mass market	46,500	22
Taxi- Premium market	46,500	18
Buses	68,200	125
Light urban freight	55,800	22

- 4.16 Based on the above assumptions, the estimated total energy demand for the EV scenarios in 2035 would be approx. 35 GWh for BAU (No intervention), 90 GWh for (BTB- Base case) and 285 GWh (BTB-Proactive case). In addition to this, there will be losses associated with EV charging system and transmission/distribution losses that together account for another 17 to 18 percent of total EV charging demand. In the most optimistic electrification scenario (Proactive), EV charging will account for 1.9 percent of total energy demand in Mongolia after considering for charging system and T&D losses. The estimated total energy demand (without EV load) in Mongolia is expected to reach 15,000 GWh by 2035 from 7,750 GWh in 2021⁴⁹ assuming annual growth rate of 4.8 percent based on historical trend for the year 2014 to 2021.
- 4.17 The EV charging demand by vehicle segment is shown in Figure 4-5 below.

⁴⁸ For annual VKT calculation, the number of operating days is assumed to be 310 days in a year.

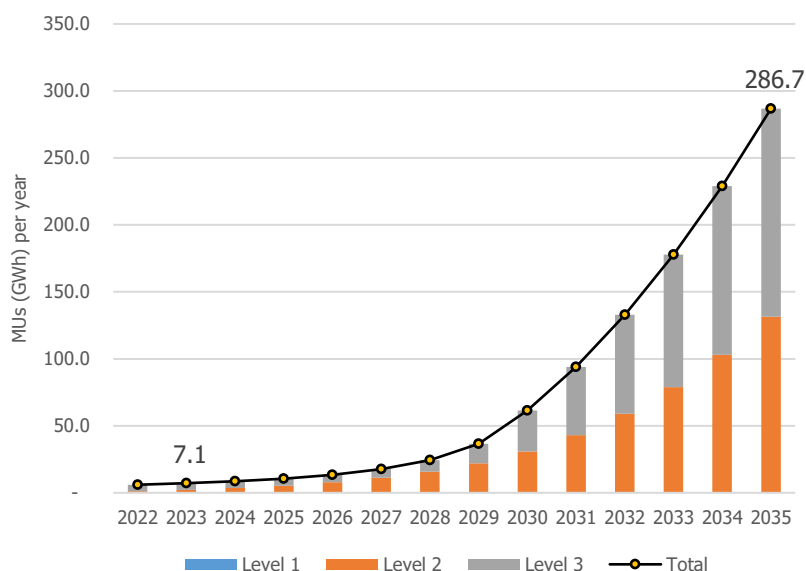
⁴⁹ The U.S. Energy Information Administration. (2021). *Mongolia Electricity consumption - data, chart* | TheGlobalEconomy.com. https://www.theglobaleconomy.com/Mongolia/electricity_consumption/

Figure 4-5: Estimated electricity demand for EV charging (Proactive case)



- 4.18 The demand break-up across vehicle segments is private cars (51 percent), taxis (18 percent), buses (25 percent) and light urban freight (6 percent). In line with this (and as shown in Figure 4-6 below) home charging (i.e. Level 2 charging) will make up 46% of demand, with captive charging (Level 3) representing (34%) and public charging (20%).

Figure 4-6: Estimated electricity demand for EV charging (Proactive case)



- 4.19 A summary of all three scenarios is provided in Table 4-6. Demand for Level 3 charging is much lower in other scenarios since adoption of e-buses and e-taxis is assumed to be negligible.

Table 4-6: EV demand summary

Approx (figures)	BAU (No intervention)	BTB (Base case)	BTB (Proactive case)
EV charging demand	35 GWh	90 GWh	285 GWh
EV charging demand as percentage of total demand	0.2 percent	0.6 percent	1.9 percent
Demand by charger type	Level 2- 80% Level 3- 20%	Level 2- 70% Level 3- 30%	Level 2- 46% Level 3- 54%
Target vehicle segment	Private cars	Private cars, light urban freights	All vehicle segments

Impact on demand peaks

- 4.20 The charging pattern would differ not only across locations but also across time slots. Based on the existing Time of Use (ToU) tariff in place in Mongolia, the charging load has been primarily categorized into following time slots as defined below in Table 4-7. This is further modelled and explored in the EV tariffs section.

Table 4-7: Charging load categorisation

Time slot	Charging time	Charging period	Duration	Location Preference	Demand %
TS1	9 pm to 6 am	Night	9 hrs.	Home > Dedicated > Public	22%
TS2	6 am to 12 noon	Morning	6 hrs.	Public > Dedicated > Home	22%
TS3	12 noon to 5 pm	Afternoon	5 hrs.	Public > Dedicated > Home	19%
TS4	5 pm to 9 pm	Peak evening	4 hrs.	Equal preference	33%

Impact on GHG Mitigation

- 4.21 Based on the estimated vehicle stock trend, annual VKT, fuel efficiency, specific emission factors for different fuels, GHG emissions are estimated for all the three scenarios, as shown in Figure 4-7 below.

Emissions factors

- 4.22 A key consideration for Mongolia is the GHG intensity of the energy grid. The grid emission factor of 0.73 kgCO₂e/kWh is for the year 2020, in which RES represents approximately 9% of total generation, which improved to 10.2% in 2021⁵⁰, resulting in a slight improvement to 0.72 kgCO₂e/kWh.
- 4.23 However, based on the forecasted load capacity for the period 2023 to 2030 as received from NDC, it is evident that Combined Heat and Power Plants (CHPPs) will continue to dominate Mongolia's generation capacity, with CHPP plant contribution to peak winter load expected to increase from 67% in 2023 to 72% by 2030. Further RE capacity expansion is not on the current policy or investment agenda, and while it is not possible to fully predict future developments, it seems unlikely that RE capacity will grow at a rate faster than baseline energy demand growth. Whilst we note the contrast with the 30% RE target outlined in the State Policy on Energy 2015-2030⁵¹, the modelled grid emission factor is assumed to be a constant factor of 0.73 kgCO₂e/kWh for the period 2021 to 2035, as shown in Table 4-8.

Table 4-8: Specific emissions factor for GHG emission modelling

	Gasoline	Diesel	Electricity ⁵²
	(kgCO ₂ e/litre)	(kgCO ₂ e/litre)	(kgCO ₂ e/kWh)
Well to Tank ⁵³ (A)	0.45	0.62	0.73
Tank to Wheel (B)	2.35	2.70	0.00
Well to Wheel (A + B)	2.80	3.32	0.73

⁵⁰ IRENA. (2022). *ENERGY PROFILE*. https://www.irena.org/-/media/Files/IRENA/Agency/Statistics/Statistical_Profiles/Asia/Mongolia_Asia_RE_SP.pdf

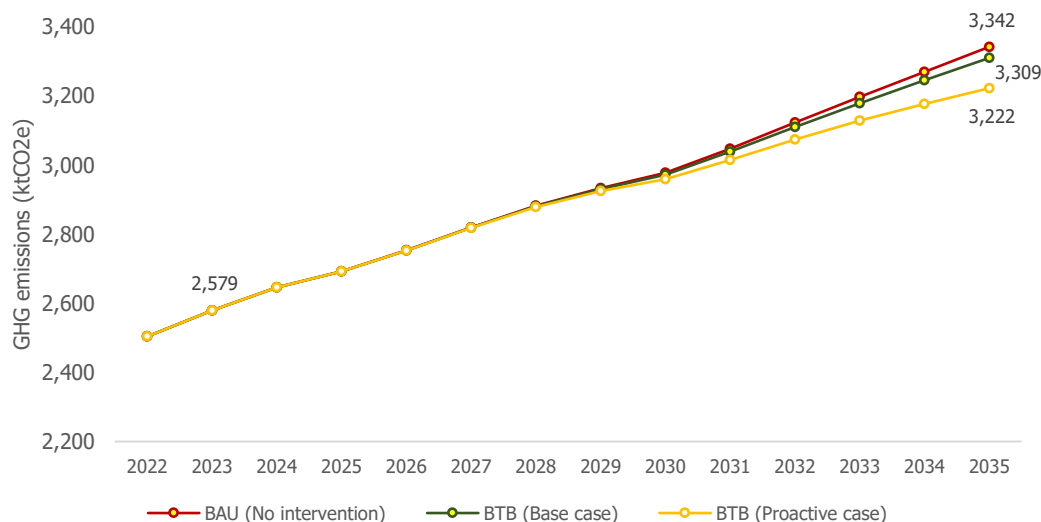
⁵¹ *Mongolia's clean Energy transition: a pathway to sustainable and inclusive development*. (n.d.). UNDP.

<https://www.undp.org/mongolia/blog/mongolias-clean-energy-transition-pathway-sustainable-and-inclusive-development>

⁵² The emission factor of 0.73 kgCO₂e/kWh is for the year 2020 considering RE share approx. 9 percent of total generation. As the RE share increases, electricity grid emission factor will improve.

⁵³ Indirect or well-to-tank (WTT) emissions are upstream fuel consumption-related emissions. These include GHG emissions for the extraction, refining, and transportation of fossil fuels, determined by using a default mark-up factor per fossil fuel type published by the UNFCCC (19% for gasoline and 23% for diesel).

Figure 4-7: GHG emissions (in kilo tons) across all scenarios



GHG impact summary

- 4.24 In a BAU (No intervention) scenario, GHG emissions from the six vehicle segments are expected to grow 30% from 2023, to approximately 3,350 kilotons CO₂, of which private cars, taxis, buses and light urban freight represent ~2,165 ktCO₂e (65 percent), 465 ktCO₂e (14 percent), 105 ktCO₂e (3 percent), and 615 ktCO₂e (18 percent) respectively. The BTB (Base case) scenario would see a reduction of 24 ktCO₂e in 2035, a reduction of less than 1% from BAU, while the Proactive scenario would see a reduction of 75ktCO₂e in 2035, around 4% lower than BAU.
- 4.25 At a vehicle stock level (for the modelled segments) GHG emission would reduce from 240 gCO₂e. per km to 238 gCO₂e per km under BTB (Base case), 235 gCO₂e per km under BTB (Proactive case), reductions of approximately 1% and 2% respectively. A breakdown of the trend across six vehicle segments is shown in Table 4-9.

Table 4-9: Stock level GHG emissions by scenario (gCO₂e. per km)

Vehicle segment	Baseline 2023	BAU 2035	BTB (Base case) 2035	BTB (Proactive case) 2035
Private cars (< 3 years)	203	199	176	173
Private automobile (> 3 years)	226	225	224	222
Mass taxi	226	226	226	218
Premium taxi	204	204	204	197
Buses	1,149	1153	1,153	1,011

Light urban freight	287	287	282	282
Vehicle stock level	240	240	238	235

Air Quality Impacts

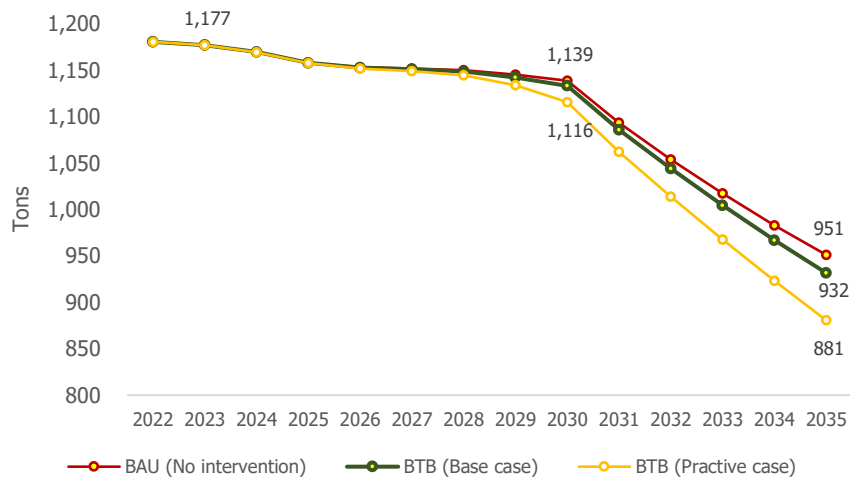
- 4.26 According to the World Health Organisation (WHO), air pollution in Mongolia results in 132 deaths per 100,000 people per year, significantly higher than the global average of 92 deaths per 100,000 people⁵⁴. Ulaanbaatar in particular is the most polluted city of Mongolia as per Air Quality Index (AQI) data tracked by various stations⁵⁵. While not the principal cause of poor air quality (compared to heating, cooking and power generation) transport is nevertheless an important contributor.
- 4.27 Air pollutant emissions from vehicles (Particulate Matter (PM), Nitrogen Oxide (NOx) and Sulphur Oxide (SOx)) are dependent on EURO standards (i.e., vehicle and fuel) and the subsequent fuel efficiency of each vehicle segments. PM and NOx are emissions related to EURO standards of the vehicle whereas the SOx emissions are related to the EURO standards of the fuel. At present, most of the vehicles in Mongolia follows EURO II standard. Therefore, transition to a more advanced emissions standards (EURO IV to VI) is a way forward for Mongolia. For analysis, we have assumed that Mongolia will switch to EURO IV standards after 2030. These impacts are shown in Figure 4-8, Figure 4-9 and Figure 4-10.

⁵⁴ World Health Organization: WHO. (2018). *World Health Organization issues recommendations to tackle health impacts of air pollution in Mongolia*. <https://www.who.int/mongolia/news/detail/28-02-2018-world-health-organization-issues-recommendations-to-tackle-health-impacts-of-air-pollution-in-mongolia#:~:text=In%202012%2C%20one%20out%20of%20nine%20deaths%20in,average%20is%2092%20deaths%20per%20100%20000%20people>.

⁵⁵ Mongolia Air Quality Index (AQI) and Air Pollution information | IQAir. (n.d.). <https://www.iqair.com/mongolia>

Particulate Matter impacts

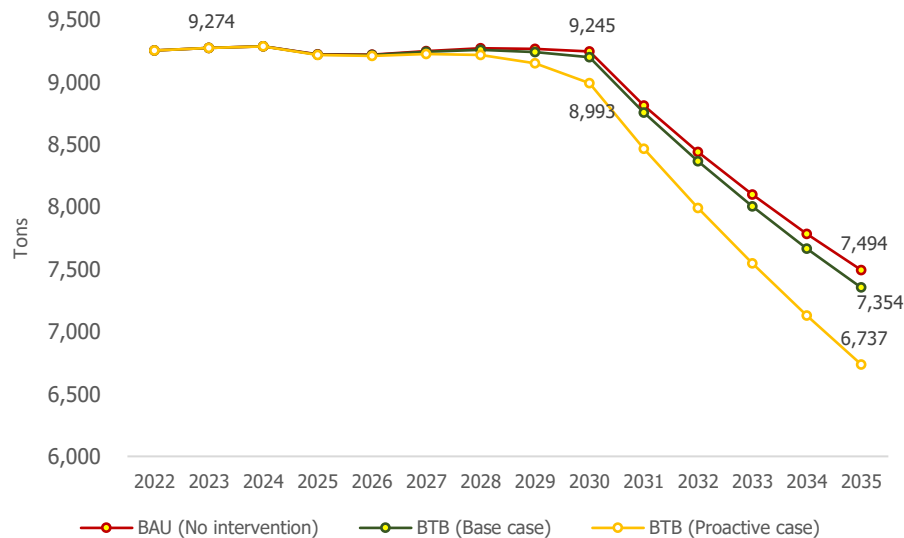
Figure 4-8: PM emissions trend across all scenarios



- 4.28 Despite continued increase in vehicle stock, the PM emission is expected to decrease over time. The decrease in PM emission until 2030 is expected to be marginal due to slower rate of electric vehicle adoption but no change in vehicle emission standard policy (i.e. Euro II only). Once new emission standards are enforced, the overall specific emission factor for PM will improve considerably across all vehicle segments. As a result, PM emissions will reduce to 951 tons from 1,177 tons in 2035 under BAU (No intervention) scenario, i.e. about 20 percent reduction from 2023 levels. These emissions levels are expected to further improve due to EV adoption in BTB (base case) and BTB (proactive case) scenarios. As a result, the PM emissions will drop to 932 tons and 881 tons in BTB (base case) and BTB (Proactive case) scenario respectively. This improvement is about 2 percent and 7.4 percent respectively compared to BAU (no intervention scenario) in 2035 (i.e. which can be attributed to air quality improvement due to EVs).

NOx emissions impact

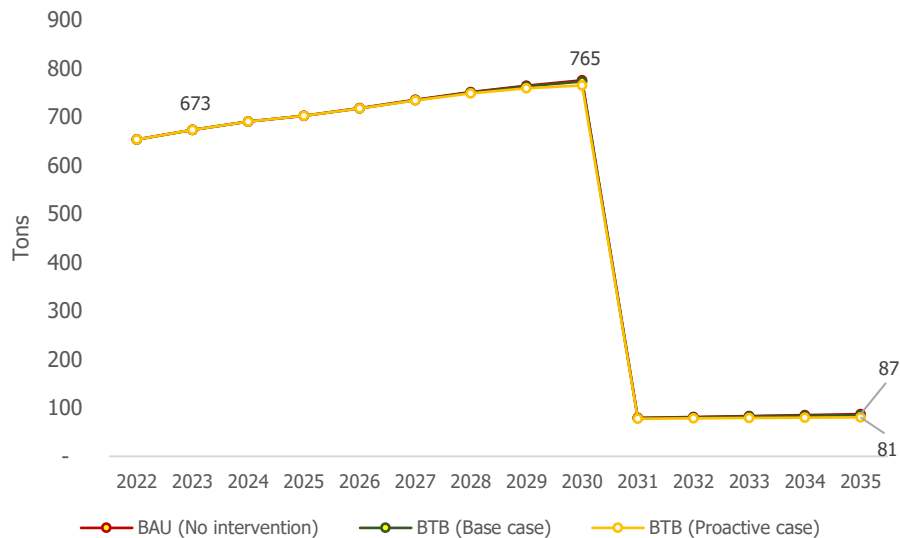
Figure 4-9: NOx emissions trend across all scenarios



- 4.29 Despite continued increase in vehicle stock, the NOx emission is expected to decrease over time. This decrease is dependent on two factors a) rate of electric vehicle adoption and b) Euro emission standard. The decrease in NOx emission until 2030 is dependent on rate of electric vehicle adoption where no change in vehicle emission standard is assumed (i.e. Euro II only). Once new emission standards are enforced, both factors effect will multiply leading to considerably improved specific emission factor across all vehicle segments. As a result, NOx emissions will reduce to ~7,500 tons from 9,300 tons in 2035 under BAU (No intervention) scenario, i.e. about 20 percent reduction from 2023 levels. These emissions levels are expected to further improve due to EV adoption in BTB (base case) and BTB (proactive case) scenarios. As a result, the NOx emissions will drop to 7,354 tons and 6,737 tons in BTB (base case) and BTB (Proactive case) scenario respectively. This improvement is about 1.9 percent and 10.0 percent respectively compared to BAU (no intervention scenario) in 2035.

SOx emissions impact

Figure 4-10: SOx emissions trend across all scenarios



- 4.30 SOx emissions are dependent on a) Euro fuel standard, b) type of fuel – gasoline or diesel, and c) volume of fuel combusted. The rate of electric vehicle adoption may have little impact and often compensated by increase in ICE vehicle stock. In above case, SOx emissions continue to increase with increase in vehicle stock (i.e. growing fossil fuel consumption). However, once new emissions standards are enforced (say Euro IV after 2030), the SOx emission is expected to fall drastically. This is because sulphur content in Euro IV is one-tenth of Euro II. As a result, SOx emissions will reduce in the range of 81 to 87 tons from 673 tons under different scenarios, i.e. about 87 percent reduction from 2023 levels. The incremental impact on SOx emissions for defined EV targets under BTB (base case) and BTB (proactive) is almost negligible compared to BAU (no intervention scenario). This is primarily because of increasing fuel consumption at a vehicle stock level.

Conclusions

- 4.31 EVs would have a supporting impact upon reducing local transport related air pollutant emissions in Ulaanbaatar. The modelling demonstrates that this impact would be a small contribution within the context of other planned policies for fuel and vehicle standard improvements which are likely to have a far greater impact in the short-medium term. While EV transition is not a realistic short-term policy measure to address air quality, it should be noted that the impact will grow significantly in the longer-term as EV adoption increases in line with global markets and consumer uptake (and as ICE vehicles are ultimately phased out).

Impact on Fossil Fuel Consumption

- 4.32 Based on the estimated vehicle growth and EV mix, gasoline and diesel consumption is estimated for the BAU and BTB scenarios, and shown in Figure 4-11 and Figure 4-12.

Figure 4-11: Gasoline consumption trend across all scenarios

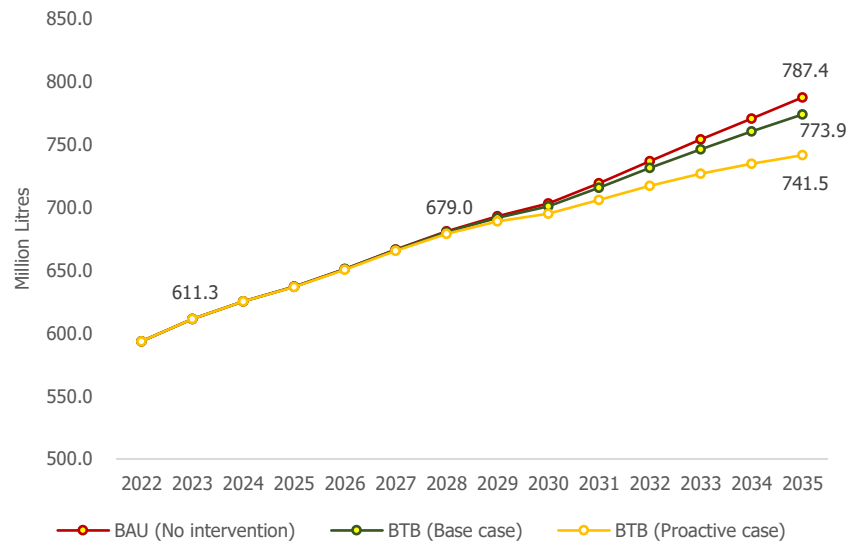
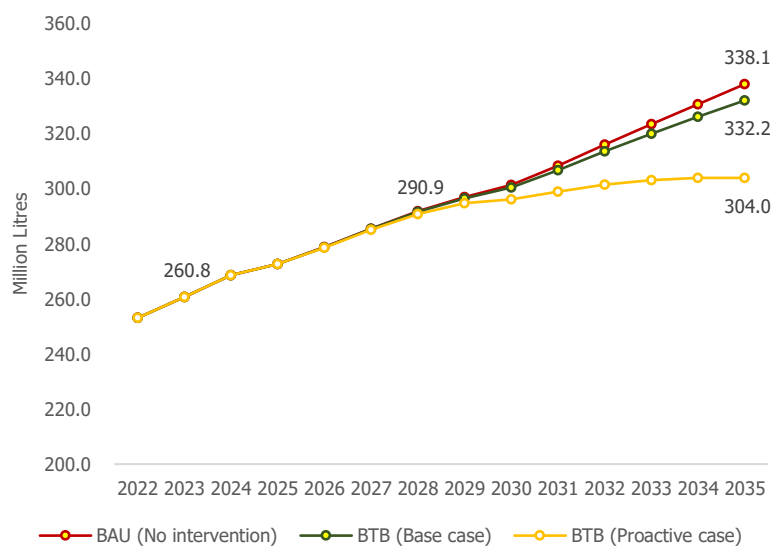


Figure 4-12: Diesel consumption trend across all scenarios



- 4.33 Under the BAU (No intervention) scenario, the consumption of petrol and diesel fuel across six vehicle segments will increase by 30% to ~790 million litres and ~340 million litres respectively in 2035 as shown in above graphs. Under the BTB (Base case) this growth would reduce slightly (to 27%), while under the BTB (Proactive case), the

demand for gasoline and diesel would grow significantly slower (21% and 16% respectively).

- 4.34 If Proactive scenario is met, the government can avoid ~45 million litres gasoline and ~35 million diesel imports every year from 2035 onwards, equivalent to \$134 million worth of fuel⁵⁶.

Economic Savings

- 4.35 There is an economic cost associated with for every ton of PM, NOx and SOx released into the atmosphere. These costs are related to mortality risks or premature deaths that occur due to adverse health effects arising from poor air quality. Each scenario has been costed based on standard methodologies outlined below, with the results presented in Table 4-10.

Table 4-10: Economic benefits from air quality and GHG mitigation impact

Approx (figures in USD Million)	BAU (No intervention)	BTB (Base case)	BTB (Proactive case)
CO2	2295 (76.4%)	2,289 (76.5%)	2,272 (76.6%)
PM	660 (22.0%)	656 (21.9%)	646 (21.8%)
Sox	39 (1.3%)	39 (1.3%)	38 (1.3%)
NOx	10 (0.3%)	10 (0.3%)	10 (0.3%)
Economic Cost	3,004 (100%)	2,994 (100%)	2,966 (100%)
Economic Savings from BAU level		10	38

Methodology for economic savings

- 4.36 **Air pollution:** As per the study conducted by the Asian Development Bank (ADB) for their Developing Member Countries (DMC), the Mongolia has been assigned moderate pollution cost level. Therefore, to calculate economic cost for Mongolia, the median cost of pollution for DMC has been considered for analysis purpose. The median cost

⁵⁶ Current price: gasoline - \$1.49 per litre & diesel - \$1.36 per litre. Assumed annual inflation: gasoline – 4.6% & diesel – 3.7%

for different air pollutants such as PM, NO_x and SO_x is USD 46,000 per ton, USD 340 per ton and USD 1,630 per ton respectively⁵⁷.

- 4.37 **GHG:** Per the World Bank carbon pricing dashboard, the carbon price ranges between USD 0.46 to USD 167 per ton. For many countries, it varies between USD 30 to USD 60 per ton⁵⁸. For Mongolia, carbon abatement economic cost assumed is USD 60 per ton. Based on these assumptions, the summary of economic cost across all three scenarios for the period 2023-2035 is given below: The total economic savings expected from BTB (Base case) and BTB (Proactive) is USD 10 million and USD 38 million respectively against BAU scenario. About 60% of these savings are due to carbon reduction impact and remaining from air pollutants.

⁵⁷ ASIAN DEVELOPMENT BANK, Grütter, J. M., & Kim, K.-J. (2019). E-Mobility options for ADB developing member countries. In *ADB Sustainable Development Working Paper Series* (Report No. 60). Asian Development Bank.

<https://www.adb.org/sites/default/files/publication/494566/sdwp-060-e-mobility-options-adb-dmcs.pdf>

⁵⁸ World Bank Group. (2024). *State and Trends of Carbon Pricing Dashboard*. Carbon Pricing Dashboard. <https://carbonpricingdashboard.worldbank.org/compliance/price>

Section 2

EV Roadmap Recommendations



a company of Royal HaskoningDHV

5. Market Development Recommendations

- 5.1 This section provides recommendations to overcome the market development barriers in the priority vehicle segments.

Assessment Methodology

- 5.2 Assessment of the suitability and prioritisation of the different incentives and initiatives used the following methodology:
- Identification of international best practice models for e-mobility support for each vehicle segment.
 - Assessment of each incentive's potential to address the barriers to electrification in each segment.
 - Assessment of each incentive's feasibility and acceptability in the Mongolian e-mobility context, including acceptability to local stakeholders, when engaged during an in-country workshop.
- 5.3 Given the resource constrained public fiscal context of Mongolia, policy/regulatory instruments are prioritised over those with public financial (e.g. financing guarantees) or fiscal impacts (investments or subsidies). This is particularly important for the private automobile sector, in which the strategy is to 'enable' private market demand (rather than active promotion).
- 5.4 Finally, shortlisted interventions were assigned to the different EV scenarios based on the extent to which they constitute limited policy/enabling support of more proactive/financial.
- 5.5 Based on the effectiveness of an incentive in overcoming a barrier to electrification for each segment and the incentive's deliverability (its feasibility and acceptability to local stakeholders, as discovered during an in-country workshop), a level of suitability has been made for each incentive in relation to each segment it is relevant to:
- Highly suitable – the incentive has a strong potential to address a barrier to electrification for the segment and believed to be feasible and acceptable to stakeholders.
 - Suitable – the incentive is strong in terms of either its effectiveness or deliverability/acceptability, but is moderate in the other criteria.
 - Suitable with specific conditions – certain incentives could work well, but only under certain circumstances, so they are only tentatively recommended.

- Not suitable - the incentive would have low effectiveness and/or low feasibility/acceptability in Mongolia.

Summary of Selected Recommendations

- 5.6 Between the different target vehicle segments, 13 recommendations have been developed for consideration in Mongolia as priorities. A summary of these are shown in Table 5-1, along with the barrier they address, and whether they are recommended in both the enabling and proactive scenarios, or just the proactive scenario.

Table 5-1: Summary of incentives recommended for Mongolia

Vehicle segment	ID	Recommendation	Barrier Addressed/ Purpose	Enabling	Proactive
Private Automobile Approach: ENABLE	D1	Citizens to be Able to Request that Public and Commercial Car Parking Spaces be Restricted to EVs/EV Charging Stations Installed	Range anxiety		
	D2	Right to Install EV Chargers in Communal Residential Parking Lots	Range anxiety Range anxiety		
	D4	Implement EURO V Fuel Standards	Reduction of GHG emissions		
	D10	Alignment of Taxation on private EVs with HEVs	Align nominal import taxed on EVs with ICE		
	D7	EV Charger Subsidy	Range anxiety Upfront cost		
	D8	EV only-restriction at EV charging spaces	Enable charging point business model		
	D6	Encouraging Banks to Finance EVs	Access and feasibility of upfront capital financing		
	D9	Reduced-fee parking for EVs (time limited)	User 'nudges' and TCO		

Light Freight Approach: PROMOTE	D1	Citizens to be Able to Request that Public and Commercial Car Parking Spaces be Restricted to EVs/EV Charging Stations Installed	Range anxiety		
	D4	Implement EURO V Fuel Standards	Reduction of GHG emissions		
	D5	Charging-as-a-service model	Reduce technical barriers for operators		
	D6	Encouraging Banks to Finance EVs	Access and feasibility of upfront capital financing		
	D11	Develop Private Leasing Business Model for EVs	Manage upfront capital cost		
	D7	EV Charger Subsidy	Address upfront cost		
Urban Taxi Approach: PROMOTE	D6	Encouraging Banks to Finance (PT) EVs	Access and feasibility of upfront capital financing		
	D4	Implement EURO V Fuel Standards	Reduction of GHG emissions		
	D12	Introduction of Battery Leasing Mechanisms	Reduce upfront costs Reduce technology risk		
	D11	Develop Private Leasing Business Model for EVs	Access and feasibility of upfront capital financing		
	D5	Charging-as-a-service model	Enable opportunity charging at key locations		
	D13	Reduced Licensing Fees for Taxi Operators with EVs in their fleet	Reduced operating costs 'Nudge'		
	D7	EV Charger Subsidy	Enable charging at depots/key locations		

Urban buses (12m) Approach: PROMOTE	D5	Charging-as-a-service model	Reduces upfront cost and technology risk for RES charging		
	D4	Implement EURO V Fuel Standards	Reduction of GHG emissions		
	D7	EV Charger Subsidy	Enable capital investment in opportunity charging		
	D11	Develop Private Leasing Business Model for EVs	Enable		
	D3	E-Bus Only Corridors	Reduces operator TCO Wider economic benefits (investment case)		

Priority Recommendations Application

- 5.7 This section outlines a summary of each of the 13 selected priority recommendations, the suggested approach for implementation of the recommendations, the key points for application in the Mongolian context and a case study to demonstrate the recommendation, if appropriate.

RECOMMENDATION D1: Mandate for Citizens to be Able to Request that Public and Commercial Car Parking Spaces be Restricted to EVs/EV Charging Stations Installed



Private Automobiles



Light Freight



Urban Buses



Taxis

Summary

- 5.8 Mandate allowing citizens to request that public or commercial car parks/street parking have spaces restricted to EVs and/or charging facilities installed. This could work on the basis that when a minimum threshold of requests is met, a proportion of spaces in the car park must become EV-only spaces/an EV charger must be installed.

The proportion of spaces/number of chargers could be based on the number of requests received, increasing as the number of requests increases. Or it could simply serve as a tool to inform local authorities of the demand for EV parking/chargers, with the local authority able to decide whether it has the resources to respond to this demand.

- 5.9 This would allow for a market-driven approach to assigning spaces to EVs. As with similar incentives for parking spaces restrictions related to EV adoption, this would provide a 'nudge' effect for citizens considering purchasing an EV in the early stages of EV adoption, giving them greater confidence of finding a parking space in the city. The incentive would help to alleviate range concerns, if drivers were confident they would not have to waste their charge on finding a car parking space, or would be able to request a public charging point near their home if home charging is not an option.
- 5.10 By allowing the market to determine where demand for these spaces is highest, it would avoid imposing EV-only restrictions in areas with low EV ownership, creating 'dead space' in car parks. This would lose revenue for both the public and private sectors, without the benefit of encouraging EV adoption.

Implementation

- 5.11 This would ideally be in the form of an online tool, which could be facilitated with the help of commercial charging providers, in the case of the request for EV chargers. For instance, in the UK, Shell Recharge provides an online form for EV owners to fill out, which then is sent to their local authority to inform them of the request for a public EV charging point near their home⁵⁹.
- 5.12 This incentive would primarily benefit early private EV adopters, but would also benefit light freight vehicles if the spaces were reserved in areas which would support their operations.
- 5.13 Citizens and companies would need to have a limit on the number of locations to request EV parking spaces, to ensure that the spaces are assigned to areas with genuine demand. The minimum threshold of requests to trigger the implementation of this mandate would also need to be revised as the number of EVs in the country grows.

Key issues for implementation in the Mongolian context

- 5.14 Enforcement of this mandate will again be key to its success. This will require the buy-in of police for the enforcement of public car parks, and possibly financial

⁵⁹ Request an EV charge point near your home with ubitricity. (2024, February 16). Ubitricity. <https://ubitricity.com/en/driver/request-a-charge-point/>

compensation for commercial operators. If the latter is deemed to be necessary, this incentive will only be feasible in the short-term, before it becomes too expensive as EV adoption grows. It would also need to be phased out in the medium- to long-term from public car parks, as EV adoption increases and this nullifies this incentive, as the chance of finding a car parking space would not be significantly increased by this restriction.

- 5.15 The case study of Shell Recharge, demonstrating this recommendation, can be found in "RECOMMENDATION S7: Strengthen EV Charger Planning and Implementation in Partnership with Private Sector Stakeholders".

RECOMMENDATION D2: Right to Install EV Chargers in Communal Residential Parking Lots



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Light Freight



Urban Buses



Taxis

Summary

- 5.16 Residential building regulation allowing residents to install home EV chargers in communal parking lots for apartment blocks. As implemented in Norway, this would not impose the requirement on developers to include EV chargers as part of new apartment buildings. Instead, this would allow the market to determine the requirement for EV chargers. Whilst this would incur a capital cost for EV adopters, it would not stifle housing development by imposing the requirement for EV chargers when it is not known if there is demand for them.
- 5.17 The regulation would still provide a 'nudge' effect, by reducing the planning barrier towards installing an EV charger at home. This could be influential for potential EV adopters, as the ability to charge private vehicles at home is crucial for EV owners (both for cost and range implications, compared to charging at commercial charging points). With many of Ulaanbaatar's citizens living in apartment blocks, this incentive would have a broad reach.

Implementation

- 5.18 The building regulation granting residents of apartment blocks the right to install EV chargers in their building's shared parking lot would need to be implemented by MUB

for Ulaanbaatar. If the regulation proved to be a success, it could be implemented in other regions in the long-term as EVs become more popular in other areas.

- 5.19 This incentive is primarily targeted at private automobile users. It is possible it could also benefit individual owner-operators of taxis and light freight vehicles storing their vehicles at home overnight. If the planned formalisation of the taxi market is accomplished, in the medium- to long-term, taxis will not be kept at residential complexes. Even in the short-term, the number of informal taxis that will be electric will be very limited, if any, given their high capital costs. Similarly, individual light freight owners will be very limited in number in the short-term.

Key issues for implementation in the Mongolian context

- 5.20 For this regulation to have any effect, it requires apartment blocks to have communal parking space assigned to it. The study team understands that many apartment blocks do not include communal parking. This will limit the potential of this incentive.



Private Automobiles



Light Freight



Urban Buses



Taxis

RECOMMENDATION D3: E-Bus Only Corridors

Summary

- 5.21 Enforced corridors exclusively for e-bus operation, providing a visible 'Green Corridor' to showcase air quality improvements and accompanied by stronger enforcement of public transport priority (either through fine enforcement or physical segregation). This is crucial to the success of BEBs in Ulaanbaatar, both in terms of technical feasibility (BEBs rapidly lose charge in stop-start, heavily congested conditions, as often is the case in UB) and the environmental case for them (the more energy required to operate them, the worse their emissions are).

Implementation

- 5.22 Creating an e-bus only corridor requires a fleet of BEBs which is large enough to maintain the desired frequency of service, accounting for time to re-charge between round trips (typically 5 to 15 minutes). There are already 55 BEBs in operation on PTA routes in UB. Depending on the route length, operating conditions (more BEBs will be

required in winter as they will lose charge at a faster rate), and the desired frequency, this will likely be enough to operate one route exclusively with BEBs.

- 5.23 Whilst the BEB fleet should be expanded, to avoid the requirement to substantially increase the size of the BEB fleet in a short period of time, the operation of BEBs could be limited to a main corridor where multiple routes operate. The BEBs could operate only along the arterial corridor itself, whilst diesel buses are changed to feeder services to complete the routes away from the arterial corridor. This would also avoid the duplication of routes along the corridor and provide a more efficient service overall. It is important that if this approach is taken, efficient transfers between BEBs and feeder diesel buses are ensured, and passengers aren't charged for transferring to feeder routes.
- 5.24 Some bus priority infrastructure exists along Peace Avenue, and is largely adhered to already, so this may be a good location to begin. Many of the BEBs also already operate along this road. Some stronger physical segregation infrastructure or fine enforcement is required at either end of the existing bus priority infrastructure to ensure BEBs are able to operate in smooth running conditions for the length of their journey.
- 5.25 In order to raise awareness of the "green corridor", the bus lanes could be painted green and be accompanied by other 'greening' of infrastructure along the corridor. Again, Peace Avenue would be a good location for this, given that trees and hedges line much of the corridor already.

Key points for application in Mongolia

- 5.26 It is worth highlighting that in order for BEBs to work effectively, economically and provide the most environmental benefits, they must operate in smooth conditions. This is not possible in mixed traffic conditions in Ulaanbaatar at present, so strong bus priority measures are required.
- 5.27 Existing bus priority infrastructure is limited in UB, and only adhered to on Peace Avenue. So, if a corridor other than Peace Avenue is chosen, more work will be needed to improve it to a standard worthy of a "green corridor". However, Peace Avenue is a very popular corridor with a number of routes operating on it, so it will require more buses to maintain a high frequency.
- 5.28 In either scenario, capital investment will be required to implement the "green corridor".

Case study: Mexico City Metrobús Line 3

- 5.29 The Metrobús Line 3 BRT route in Mexico City has operated using only electric buses since 2023⁶⁰. The route is 20 km long with 38 stations and opened in 2011⁶¹.
- 5.30 In partnership with C40 Cities and the International Council on Clean Transport (ICCT), a pilot of ten Yutong articulated buses was deployed in 2021⁶¹. Given the pilot's impressive performance, Metrobús and Movilidad Integral de Vanguardia (MIVSA - the BRT's operator) decided to acquire more electric buses.

Figure 5-1: Launch of BYD e-bus fleet



Source: BYD

- 5.31 The line is now operated by a fleet of 50 articulated 18 m electric buses, financed by Banco Santander México⁶⁰. The success of the e-buses is in no small part due to the strong bus priority of the BRT line they operate on.
- 5.32 Line 3 has served as a proof-of-concept for the city, whose ambition is to transition to a fully zero-emission fleet by 2035. With this objective in mind and the success of the

⁶⁰ Wanek-Libman, M. (2023, February 21). Mexico City begins operations on all electric BRT route. *Mass Transit*. <https://www.masstransitmag.com/bus/vehicles/hybrid-hydrogen-electric-vehicles/article/53012937/mexico-city-begins-operations-on-all-electric-brt-route>

⁶¹ Mexico City introduces new e-buses with support from ZEBRA - C40 Cities. (2023, March 9). C40 Cities. <https://www.c40.org/news/mexico-city-e-buses-zebra/>

e-buses on Line 3, the BYD e-buses are now being rolled out to Line 4 (a 35 km route with 40 stations).⁶²

RECOMMENDATION D4: Implement EURO V Fuel Standards



Private Automobiles



Light Freight



Urban Buses



Taxis

Summary

- 5.33 A planned action towards Mongolia's Nationally Determined Contribution (NDC) is to switch to EURO V fuel standards. EURO V fuel standards permit a maximum of 10 ppm of sulphur in petroleum products⁶³, compared to, for example, 501-2,000 ppm under EURO II standards. Implementing and enforcing EURO V fuel standards helps to limit the emissions of all vehicles, regardless of their emissions rating.
- 5.34 If EURO V fuel standards were strictly adhered to, this could result in an increase in fuel costs for drivers⁶³. This would increase the TCO of ICE vehicles slightly and make the TCO more comparable to EVs. Whilst not a reason for recommending EURO V in itself, given the negative impact it will have on low-income groups, this is nevertheless a consequence of a policy the government already plans to pursue to combat air pollution and reduce GHG emissions.
- 5.35 Mongolia's single-supplier model for petroleum means its supply chain is vulnerable to disruption.
- 5.36 As Mongolia's ambition to move to EURO V is an action towards reaching its NDC goals, the implication is that MOET (the owner of Mongolia's NDCs) is aiming to implement EURO V fuel standards by 2030.

⁶² Editorial Staff. (2024a, January 8). *BYD has delivered 20 15-meter e-buses to Mexico City (out of a 55-units deal) - Sustainable Bus*. Sustainable Bus. <https://www.sustainable-bus.com/electric-bus/byd-has-delivered-20-15-meter-e-buses-to-mexico-city-out-of-a-55-units-deal/>

⁶³ *Breathing easy for the future: Mongolia needs better long-term measures against air pollution*. (n.d.). <https://asia.fes.de/news/mongolia-air-pollution.html#:~:text=The%20country%20has%20adopted%20its,of%20501%E2%80%932000%20parts%20per>

Implementation

- 5.37 In order to implement EURO V fuel standards effectively, Mongolia must ensure it has a robust supply of EURO V fuel, a system to check standards are adhered to, and enforcement of deterrents if suppliers are found to be non-compliant.
- 5.38 In terms of supply of fuel, Mongolia must consider carefully its supply chain's ability to ensure a stable supply of EURO V petroleum to the country. If a decision is taken to diversify, this process is likely to take place in the medium- to long-term.
- 5.39 MOET or an arm of the Traffic Police will need to take ownership of checking that fuel stations are selling EURO V compliant fuel. And they should also be responsible for enforcing deterrents, such as fines, for fuel stations found to be selling petroleum that is not EURO V standard. This monitoring and enforcement should be ready to begin by 2030, to align with MOET's goals for EURO V fuel standard implementation.

Key issues for application in Mongolian context

- 5.40 Mongolia's dependence upon one supplier for petroleum imports means its supply chain is vulnerable to disruptions. Currently, the majority of petroleum from its supplier is EURO V standard⁶⁴, but without a specific policy to enforce this as a minimum standard, there is a lack of motivation for either the suppliers or distributors to provide high quality fuel.

RECOMMENDATION D5: Support Charging-as-a-Service Models



Private Automobiles



Light Freight



Urban Buses



Taxis

Summary

- 5.41 Charging-as-a-Service (CaaS) provides EV owners, typically businesses and public transport operators, with a charging solution for their fleet. The charging vendor owns the charging stations, and the fleet owners pay an all-inclusive cost for their charging needs. This includes not just the physical hardware, but the software requirements, and the project management, installation and maintenance of the charging infrastructure.

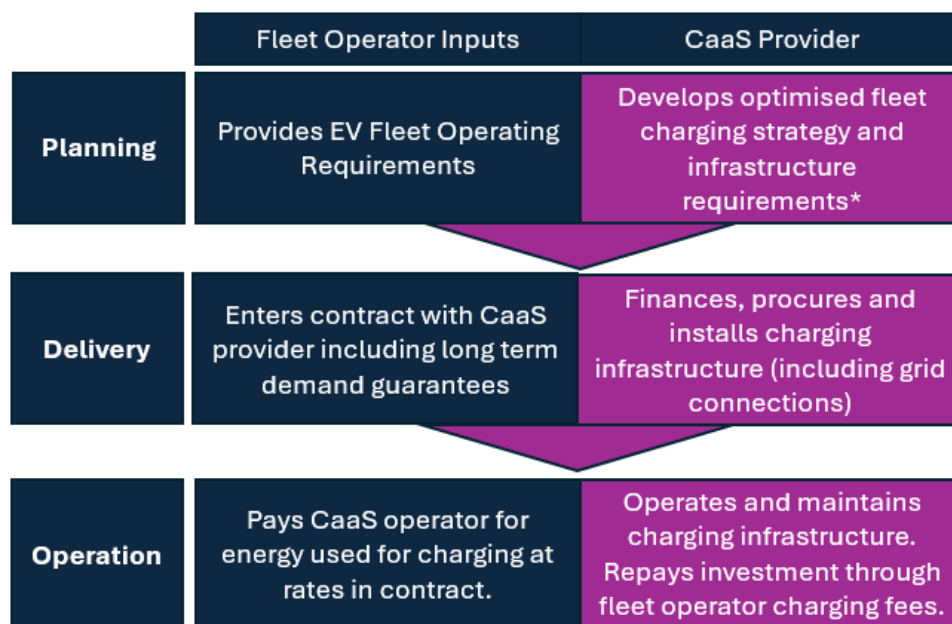
⁶⁴ Energy Fact Sheet: Why does Russian oil and gas matter? – Analysis - IEA. (2022, March 21). IEA. <https://www.iea.org/articles/energy-fact-sheet-why-does-russian-oil-and-gas-matter>

- 5.42 This not only significantly reduces the upfront costs of charging infrastructure for fleet owners, making the costs more manageable, it manages concerns owners/operators may have over an area they are typically less familiar with. The key responsibilities and processes for implementing CaaS are shown in Figure 5-2 below.

Implementation

- 5.43 There are no CaaS operators in Mongolia at the time of writing, so the GoM and/or MUB may need to encourage and/or support CaaS operators to enter the market. A good segment to start with would be buses, as this segment is more within the control of the public sector than the taxi and light freight segments. The introduction of CaaS could also be linked to a wider package of supportive measures for BEBs, such as the introduction of an e-bus only corridor with strong bus priority. This could initially be piloted with a single fleet operator, before being expanded to other operators in the medium- to long-term as lessons are learnt from the initial experience.
- 5.44 CaaS could provide an opportunity to link new charging facilities to renewable energy generation. The MUB could stipulate that any CaaS providers would have to generate a certain proportion of the energy used at their facilities through on-site RE installations (most likely solar). This would further the green credentials of BEBs and help to build the environmental case for their adoption.
- 5.45 This would be much harder to implement in the largely private light freight segment, as the MUB does not have the power to implement clauses in contracts/licenses in this segment. However, the light freight segment includes large companies with fleets of vans, who may be interested in adopting CaaS without the intervention of the government.
- 5.46 However, the taxi segment is largely made up of informal individual owner-operators, rather than fleets of taxis. CaaS only works as a business model supporting a fleet of vehicles, so it will be difficult to bring operators into this segment in the short- to medium-term. It will rely on the formalisation of the taxi segment in the long-term.

Figure 5-2: Overview of Charging as a Service implementation for EV fleets



* This can include renewable generation requirements as specified by the fleet operator

Key points for application in Mongolian context

- 5.47 The taxi sector would need to be more formalised to broaden the reach of CaaS in Mongolia. Users would need to be certified as genuine taxi drivers to ensure the services did not become overrun.
- 5.48 The hybrid hub concept showcased by Fleete below may be difficult to introduce in Ulaanbaatar, as there is a limited number of large car parks and trading estates in the city. It may be possible to introduce a greater number of smaller hybrid hubs, instead.

Case study: Fleete, Australia

- 5.49 Fleete is a Charging-as-a-Service provider in Australia, working with operators of buses, trucks and vans looking to electrify their fleets. The company provides the charging infrastructure and installation, as well as their proprietary software platform, which manages schedules and optimises energy consumption, for a monthly fee with no upfront costs.⁶⁵

⁶⁵ Macquarie Asset Management's Green Investment Group launches new EV infrastructure business, Fleete. (n.d.). <https://www.greeninvestmentgroup.com/en/news/2022/macquarie-asset-managements-green-investment-group-launches-new-ev-infrastructure-business-fleete.html>

- 5.50 The company provides a range of chargers, from 60kW to 600kW, to provide a mixture of energy-efficient, overnight charging and demand-responsive, rapid charging, potentially providing 100km of range in 10 minutes.
- 5.51 Charging infrastructure solutions are provided for three types of location:
- Large scale depots with vehicles parked overnight
 - For smaller clients, hybrid hubs developed with an anchor client to develop charging hubs in cities (e.g. trading estates or car parks) for multiple fleets with varying-sized vehicles, such as taxis and light freight vehicles
 - Inter-city chargers, located near motorways for truck and coach fleets
- 5.52 The service includes advice on layout, design, build and operation, as well as on electric vehicle choice. Fleete's smart charging software manages charging schedules to take advantage of cheaper overnight tariffs where possible, helping to manage demands on the grid.
- 5.53 The business is an arm of Macquarie Asset Management's Green Investment Group to support operators of commercial electric vehicles.

RECOMMENDATION D6: Encouraging Banks to Finance EVs



Private Automobiles



Light Freight



Urban Buses



Taxis

Summary

- 5.54 In some EV segments in Mongolia, the TCO for EVs is favourable or at least comparable. However, upfront costs and financing (availability and cost) are a barrier to uptake. Financial institutions (FIs) can be hesitant to finance EVs given the market is still in its early stages. This comes with both real and perceived risks, meaning banks and non-banking finance companies (NBFCs) may need encouragement to lend to this sector.
- 5.55 The capital cost differential for urban buses and taxis is too great for private operators to finance with private loans, even if they are guaranteed by the government. So, these aren't viable segments for this recommendation.

Implementation

- 5.56 To create an enabling environment for EVs, further interventions should be made to make EV financing more widely available and viable:
- Loans for longer terms (and at interest rates which make longer terms viable)
 - Ability to finance greater amounts.
- 5.57 Given the business model of EV concessional financing via commercial lenders already exists, the following should be considered:
- Setting up a guarantee fund to reduce risk for EV financing in light of the greater capital investment cost. As with MGFC, this could consider use of climate financing as a possible source.
 - Extension of the scope of existing concessional financing, increasing the threshold for the lowest concessional financing rate to an amount able to support a wider range of mass market and mid-range EVs. For example, were it doubled to 100m MNT this would also cover the cost of mid-range used EVs more suited to the Mongolian context.

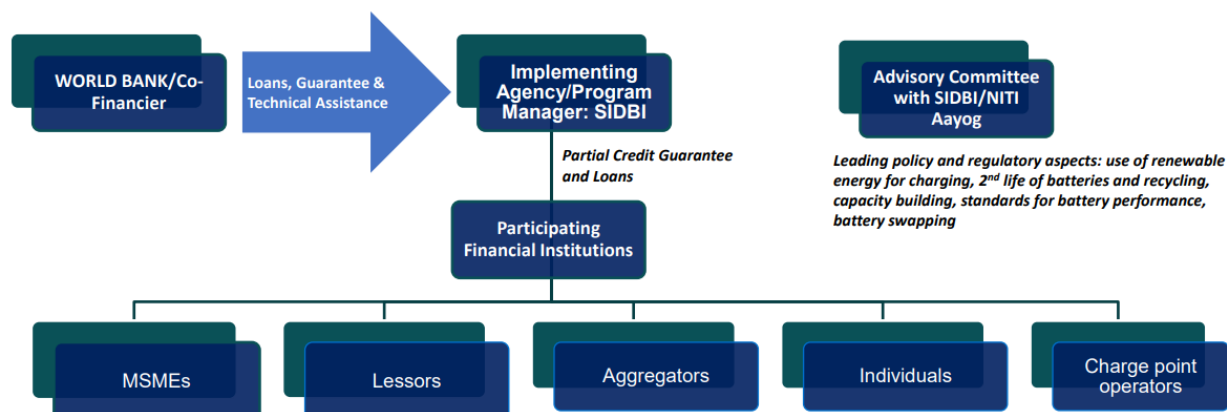
Case study: EVOLVE, India

- 5.58 The EVOLVE (Electric Vehicle Operations and Lending for a Vibrant Ecosystem) financing scheme, a collaboration between the World Bank and SIDBI (Small Industries Development Bank of India), is in development and plans to incorporate partial loan guarantees for commercial financing of electric two- and three-wheeler vehicles and charging infrastructure^{66,67}.
- 5.59 The partial loan guarantee would be supported by a concessional loan to enable lower interest rates. The partial credit guarantee would help to cover potential losses incurred by Participating Financial Institutions providing the EV loans, thereby de-risking the venture and also helping to provide lower interest rates on the loans.

⁶⁶ Government of Bangladesh/UNESCAP. (2023). *UNLOCKING FINANCING FOR THE EV-TRANSITION IN INDIA*. <https://www.unescap.org/sites/default/d8files/event-documents/Day1-3WorldBank.pdf>

⁶⁷ SIDBI. (2024). *Unlocking e-mobility*. https://www.sidbi.in/uploads/article/articlefiles/Unlocking%20emobility_eseries%20volume%20I.pdf

Figure 5-3: The potential structure of EVOLVE

Source: World Bank⁶⁶

RECOMMENDATION D7: EV Charger Subsidy



Summary

- 5.60 A public capital subsidy provided to charging point operators, fleet owners/operators or property managers/owners to cover part of the upfront cost of purchasing and installing charging facilities. This may stipulate conditions, such as charger specification requirements (e.g. smart charging standards, availability), location of installation, and potentially conditions attached to commercialisation of energy (e.g. energy cost calculations, availability, etc). The location of the installation of the chargers could be based on an EV Planning Map, as proposed in “RECOMMENDATION S7: Strengthen EV Charger Planning and Implementation in Partnership with Private Sector Stakeholders ” in the Energy Sector Recommendations section of this report.
- 5.61 This subsidy helps reduce upfront capital costs, and to incentivise installation of charging points which may otherwise not be commercially viable in these early stages of EV deployment. It could be thought of as an alternative delivery model for the public sector “1,000 charger” programme, with the advantage that it promotes the

long-term development of a commercial charging sector (leveraging private investment) while retaining influence over the development of the sector.

Implementation

- 5.62 The purpose for providing the finance (and the financial thresholds for this incentive) would have important differences across the modes:
- For semi-captive slow charging, the subsidy would support property managers and owners to provide captive/semi-captive charging infrastructure in communal buildings (e.g. apartment blocks). This could be supported by smart charging/Time of Use (TOU) tariffs.
 - For public slow charging – overnight charging in residential areas without parking. For example, chargers in lamp posts.
 - For public fast and larger destination charging (e.g. workplace) it would support costs associated with smart charging to manage impacts. It would also help to shift demand away from the peak (which would typically be when home charging occurs).
 - For commercial vehicle fleets (and potentially e-buses), the subsidy will support installation of depot charging infrastructure, which may have a higher cost due to the need for smart charging hardware or grid connection upgrades. May also include support for cost associated with local RES to mitigate energy demand and decarbonise.
- 5.63 The delivery of the subsidy poses a unique issue for the taxi sector. The sector is fragmented and informal, with most taxis operated by owner-drivers and without a formal licence. While formal licencing is a future goal of MUB, in the meantime liaison with formal taxi companies and ride-hailing companies can be used as a gateway for consultation and to identify key locations for public or semi-captive charging points for taxis, which can then be agreed through charging point operators or other facilities with high taxi use (e.g. shopping centres, transport terminal operators).

Key issues for application in Mongolian context

- 5.64 Whilst charging infrastructure is typically less expensive than EVs⁶⁸, meaning the funding required for a charger subsidy would be less than a vehicle subsidy, this could still be an expensive subsidy for the Government. Therefore, it's important that the funding for this is targeted and effective. A subsidy for captive chargers would likely

⁶⁸ Point, P. (2024, July 26). Business models for commercial EV charging. *Pod Point*. <https://pod-point.com/guides/business/ev-charging-business-models>

support a greater number of vehicles, but with more expensive equipment, as fast chargers would probably be needed to satisfy the requirements of the fleets (e.g. light freight vehicles needing to charge between deliveries, buses needing to charge between journeys). On the other hand, public slow charging facilities would be cheaper per unit, but a greater number of units would be required to reach a similar number of vehicles.

- 5.65 Whatever the technology that is decided to be supported, an assessment of the demand and reach of chargers installed should be made before a subsidy is granted, for instance with an EV Planning Map, as suggested above.

Case study: UK EV Charge Point Grants & Incentives

- 5.66 The UK Government provides a number of subsidies targeted at different types of charging points and operators/owners⁶⁹, including:
- EV charge point grant
 - EV infrastructure grant
 - The On-Street Residential Charge Point Scheme (ORCS)
 - The Local Electric Vehicle Infrastructure (LEVI) scheme
 - Workplace Charging Scheme
 - The Rapid Charging Fund
- 5.67 Landlords can apply for the EV charge point grant or the EV infrastructure grant to help fund EV charger instalment at their properties⁷⁰. The EV charge point grant can fund up to 75% of a charge point purchase and installation, up to £350 (~\$450) per grant, and can be used for commercial or residential properties. The EV infrastructure grant can be up to £30,000 (~\$38,000) depending on the number of chargers being installed and relates to costs such as wiring and posts.
- 5.68 Local Authorities can apply for the ORCS⁷¹ funding schemes to support and deliver the transition to EVs. The ORCS scheme can provide up to 60% of the funding of capital costs in procuring and installing on-street charging infrastructure (including at Local Authority-owned car parks), up to a value of £7,500 (~\$9,500).

⁶⁹ 2024 Guide to Electric Vehicle Charging Grants | MER UK. (2024, May 24). Mer UK. <https://uk.mer.eco/news/government-guide-incentives-grants-for-evs/>

⁷⁰ Government Digital Service. (2022, September 27). *Electric vehicle chargepoint and infrastructure grants for landlords*. GOV.UK. <https://www.gov.uk/electric-vehicle-chargepoint-grant-landlords/eligibility>

⁷¹ *On-Street Residential Chargepoint Scheme guidance for local authorities*. (2023, October 20). GOV.UK. <https://www.gov.uk/government/publications/grants-for-local-authorities-to-provide-residential-on-street-chargepoints/grants-to-provide-residential-on-street-chargepoints-for-plug-in-electric-vehicles-guidance-for-local-authorities>

- 5.69 Businesses can apply to the Workplace Charging Scheme⁷², which can fund up to 75% of the costs of purchase and installation of EV charging points to a maximum of £350 (~\$450) per charging socket and a maximum of 40 sockets.

RECOMMENDATION D8: EV-Only Restriction at EV Charging Spaces



Private Automobiles



Light Freight



Urban Buses



Taxis

Summary

- 5.70 A mandate for EV-only parking at spaces positioned next to EV charging stations in public car parks. A time limit for EVs charging at these spaces would need to be included in the mandate, to ensure sufficient availability of EV chargers for potential users. This would need to vary for fast and slow chargers (e.g. up to 4 hours for slow chargers, and up to 1 hour for rapid chargers, based on typical charging times⁷³). Similarly, the mandate would also need to stipulate that only EVs actively charging at the spaces could park in the space.
- 5.71 Given users will be paying a fee for charging their vehicle, paying an additional parking charge may be off-putting for prospective EV owners. In practice, the unit price of electricity at charging stations could incorporate a parking charge, but paying it in one rate would be less of a psychological deterrent to EV users.
- 5.72 The mandate would help to ensure the availability of chargers for EV users, reducing range anxiety through the assurance of opportunity charging if required. It would also support the productivity of charging stations for their operators, by deterring ICE vehicle owners from occupying a space or EV owners from staying in a space for much longer than the charging time of their vehicle. If this was not controlled, it would deny charging station operators potential revenue from EV users in need of power for their vehicle.
- 5.73 The provision of dedicated parking spaces for EVs may also be attractive if parking restrictions are introduced and enforced. If parking in the city centre is limited and parking places are at a premium, the higher likelihood of being able to find a parking

⁷² [Withdrawn] Workplace Charging Scheme: guidance for applicants. (2023, October 3). GOV.UK. <https://www.gov.uk/guidance/workplace-charging-scheme-guidance-for-applicants>

⁷³ Electric car charging speeds explained | RAC Drive. (n.d.). <https://www.rac.co.uk/drive/electric-cars/charging/electric-car-charging-speeds/>

space, even if an EV user has to pay for charging that they might not otherwise have used, may be attractive.

- 5.74 This incentive would act as a 'nudge'⁷⁴ towards EV adoption. Although not necessarily a deciding factor in itself, it could form part of a wider array incentives, which together could persuade citizens to purchase an EV over and ICE or HEV equivalent.

Implementation

- 5.75 The mandate would first need to be piloted in Ulaanbaatar, where the majority of early EV adoption has been, and will continue to be in the short- to medium-term. This would likely be mandated by MUB, who have already delivered 25 charging stations in the city and created a mandate with parking lots identified for future EV charging station instalments.
- 5.76 Ideally, this would be supported by a building regulation to ensure a certain proportion of parking spaces are provided with EV chargers.
- 5.77 Its application would need to respond to EV adoption in Mongolia. In the short-term, whilst EV adoption across segments remains relatively low, the legislation could allow any EV to park in any EV charging space while charging. This would enable light freight and taxi fleets to use public charging networks for opportunity charging during their operation. Without the availability of opportunity charging away from the fleet depots, vehicles would need to return to their depots for opportunity charging, which would be much less efficient and a barrier to their use in the light commercial sector.
- 5.78 However, as the charging network expands and the number of both private and commercial EVs grows, EV charging stations can be dedicated specifically to taxis in certain locations, to ensure private and commercial EV users are able to find EV charging stations when necessary. The legislation should still ensure that only EVs using charging stations are allowed to charge at the designated charging spaces.
- 5.79 The mandate for charging EVs-only at EV charging station spaces can only be effective if it is well-enforced. Without proper enforcement, ICE vehicle users and EV users who do not need to charge their vehicles will use the stations, meaning EV charging station owners will lose out on potential revenue. A fine for non-compliant drivers should be included as part of the mandate.

⁷⁴ Nudge Theory, presented by Richard Thaler and Cass Sunstein, suggests that the environment can be shaped to influence consumers' decision making, whilst maintaining a sense of freedom of choice (see reference below). Parking restrictions could be considered as 'shaping the environment', or 'choice architecture'. *What is Nudge Theory?* (n.d.-b). Imperial College London. <https://www.imperial.ac.uk/nudgeomics/about/what-is-nudge-theory/>

Key issues for application in Mongolian context

- 5.80 As parking regulations are not strictly enforced at present in Mongolia, the enforcement of EV-only parking regulations would need to form part of a wider drive to improve parking restriction enforcement. This would require more wide-spread reform and development of a parking enforcement department of the police, as well as private enforcement by commercial car park operators.
- 5.81 Parking restrictions could be enforced through parking enforcement officers or technological solutions, such as Automatic Number Plate Recognition (ANPR) cameras, or a combination of the two.
- 5.82 To ensure the cooperation of police in enforcing public parking restrictions, the benefits of parking enforcement to circulation of traffic and contribution towards Ulaanbaatar's sustainable mobility objectives should be emphasised, alongside additional funding for the resources this would require. A portion of the revenues generated by parking restrictions and their enforcement could be used to cover the costs of parking enforcement.
- 5.83 Commercial car park operators should already be enforcing parking time restrictions, given it is in their financial interest to do so. They should also be incentivised to enforce EV-only restrictions at charging stations, given the additional revenue available from vehicles charging. It may take operators time to decide a charge rate which factors in the opportunity cost of an ICE vehicle which could have used the space were it not for the restriction, while the EV charging space remains empty. However, this is an unlikely circumstance, given it would require the whole car park to be full, except for empty EV charging spaces. This will become even less likely as EVs become more popular.

Case study: SK electlink EV charging stations with camera monitors, South Korea

- 5.84 SK electlink, a South Korean EV charging station provider, has introduced ultra-fast charging station equipment monitored by cameras to support the usage of their facilities⁷⁵. This forms part of a "charging interruption prevention system" championed by the charging service provider, aimed at providing drivers with a smooth charging experience. A booking system allows customers to charge without waiting for a charge

⁷⁵ Press Release < PR > SK Networks. (2023).

https://www.sknetworks.co.kr/en/promotion/pressView.do?PRE_IDX=15715&curPage=2&keyword=&search=

point, supported by the charging interruption prevention system, which prevents unauthorized occupation of a charging space.

- 5.85 The ultra-fast charging stations have been deployed across South Korea at 62 express service areas, targeted at drivers needing to re-charge quickly and continue with their journey.
- 5.86 AI deep-learning technology can detect the registration plates of vehicles with the camera and identifies vehicles parked illegally in the charging space or vehicles parked for a long time after they have finished charging. Penalties are imposed for vehicles that do not leave once they have completed charging, ensuring the turnover and availability of charging points⁷⁵.

Figure 5-4: SK electlink charger opening ceremony in Cheongju Service Area



Source: SK electlink

- 5.87 The charging stations are also equipped with thermal cameras to monitor the temperature of chargers to detect chargers which are overheating and prevent fires.

RECOMMENDATION D9: Reduced-Fee Parking for EVs



Private Automobiles



Light Freight



Urban Buses



Taxis

Summary

- 5.88 As an expansion of the EV-only restriction for EV charging stations parking spaces, parking fees for EVs should be reduced as an additional benefit for EV users, even when not charging their vehicles.
- 5.89 Although this would not have a significant impact on the TCO of EVs, it would provide another 'nudge' towards EV adoption. This would help to encourage their adoption without undermining the objective of controlled parking to contribute to Ulaanbaatar's sustainable urban mobility strategy by discouraging personal automobile use, whilst monetising public space.

Implementation

- 5.90 MUB could implement an EV parking charge rate for its public car parks in Ulaanbaatar, but it would not be able to implement this in commercial car parks. It may struggle to implement this at commercial car parks, unless it offers to compensate commercial car park operators for the revenue lost to EV discount rates. This subsidy would be feasible in the short-term, given the low figures involved. However, this would need to be repealed as EVs become more popular, making this subsidy increasingly expensive.
- 5.91 The MUB should not mandate car park charge rates to commercial operators, as this would undermine the market's ability to set competitive prices based on market demand.
- 5.92 This incentive would only be applied in the short- to medium-term, to 'nudge' consumers towards the early adoption of EVs. As EVs become more popular, this discount will become too expensive, and will have to be repealed.
- 5.93 The discount could apply to all EVs, but in practice this would mostly benefit private EV owners, as they would be most likely to take advantage of restricted public parking. It would also primarily benefit early adopters of EVs, meaning it will mostly benefit mid-range and new private vehicle owners. Light freight vehicles needing to use restricted public parking could also benefit from the discount. Taxis should be either parked at taxi ranks or at charging bays, so they would not benefit from this measure.

Key issues for application in Mongolian context

- 5.94 Like the EV-only restriction at EV charging bays, the success of this incentive is dependent upon parking fees being introduced and enforced at public car parks in Ulaanbaatar. This will require a department of the traffic police to be dedicated to parking enforcement for public car parks. Again, this will require buy-in from the police and possibly a portion of parking and enforcement revenues being used to fund parking restriction enforcement.
- 5.95 Parking restriction enforcement could be implemented with parking enforcement officers, who would be able to tell EVs apart from other vehicles by their green number plates, or a technological solution (e.g. ANPR cameras which are linked to a database of registered EVs), or a combination of the two.

Case study: Lewisham emissions-based parking charges, UK

- 5.96 Lewisham Borough Council in London, UK, introduced an emissions-based parking charge structure in January 2020⁷⁶. The short-stay parking charge structure as of April 2024 is shown in Table 5-2 below. The charge structure is based on CO₂ emissions from a vehicle per km, but there is also a £2.15 surcharge for diesel vehicles on top of the petrol charge⁷⁷, to account for diesel vehicles' higher PM emissions.

Table 5-2: Lewisham short-stay parking charge structure

Emission band (gCO ₂ /km)	Hourly parking Charge		
	EV	Petrol	Diesel
Band 0 (Electric Vehicles only)	£1.62	-	-
Band 1 (1-100)	-	£2.15	£4.30
Band 2 (101-130)	-	£2.58	£4.73
Band 3 (131-165)	-	£3.12	£5.27
Band 4 (166-200)	-	£3.55	£5.70
Band 5 (201+)	-	£4.31	£6.46

⁷⁶ Cuffe, G. (2021, July 13). Lewisham council plans to triple parking fees for diesel drivers. *News Shopper*. <https://www.newsshopper.co.uk/news/19439610.lewisham-council-plans-triple-parking-fees-diesel-drivers/>

⁷⁷ Emissions-based parking charges. (2024). Lewisham Council. <https://lewisham.gov.uk/myservices/parking/changes-to-pay-and-display-parking>

- 5.97 Originally, electric vehicles were included in Band 1, along with the lowest emitting petrol and diesel vehicles. However, a new Band 0 was created in April 2023 for EV⁷⁸, to further incentivise EVs over petrol and diesel vehicles.
- 5.98 In order to implement the emissions-based parking charge at short-stay car parks, the Council operates a mostly cashless system. Drivers are encouraged to use the PayByPhone app, or they can use a call- or text-based system. Drivers wanting to pay with cash must find a nearby shop offering a PayPoint option. The payment systems use the vehicle's registration plate number to source the vehicle model and its emissions rating.
- 5.99 Lewisham Borough Council applies an emissions-based charge structure to its parking permits, as well as its short-term car parks and on-street parking. The Council provides an online permit calculator tool for its residents.

RECOMMENDATION D10: Alignment of Taxation on private EVs with HEVs



Private Automobiles



Light Freight



Urban Buses



Taxis

Summary

- 5.100 EV customs tax and VAT alignment with HEV equivalents. The higher capital costs of EVs are compounded by their tax burden, given that customs tax and VAT are a proportion of the vehicle value. To help bring EVs closer to parity with their HEV (and ICE) equivalents, it is recommended that the approximate nominal value of tax raised by HEV private automobiles is applied to EVs, instead of a proportion of their cost. This way, the government's income is not reduced from the equivalent it would have received from HEVs (the most common fuel type in this segment), whilst making the upfront cost of EVs slightly more affordable.
- 5.101 Whilst the extent to which this recommendation makes the upfront cost of mass market automobile EVs more affordable is relatively limited in isolation, it's combined effect with other "nudge" recommendations could help to influence those looking to buy a mass market automobile. It will be more effective, however, at incentivising mid-level/new vehicle purchasers to choose EVs, as the initial cost of the vehicle is more

⁷⁸ How our new parking policy has affected parking permit prices. (n.d.). Lewisham Council.
<https://lewisham.gov.uk/myservices/parking/how-our-new-parking-policy-will-affect-parking-permit-prices>

comparable to ICE vehicles in this segment. Potential buyers in this segment are also more likely to have the ability to pay a slight premium upfront for longer-term savings (from lower operator costs). The lower that premium is, the more likely they will opt for EVs.

- 5.102 VAT on all vehicle sales in Mongolia is 10% and customs duty is 5%, at the time of writing (2024). A reduction on these taxes for EVs could help to bring their initial capital costs in-line with, or even below, HEV and ICE vehicle equivalents, depending on the segment. For instance, a reduction of customs and VAT taxes to 2.5% each would bring a typical electric van's cost on import from approximately \$2,000 higher than a typical ICE van, to \$2,000 lower⁷⁹.
- 5.103 The country's excise duty rates are already graduated to benefit newer vehicles and EVs over HEVs and ICE vehicles, offering significant discounts for EV users at a flat rate of \$109, regardless of their age. This compares to around \$2,000 and \$1,700 for typical mass-market private automobiles. It is recommended that this structure remains the same.

Implementation

- 5.104 It would be impractical to differentiate a nominal tax rate for private automobile EVs, and it made dissuade EV sales for vehicles on the verge of being considered "mass-market", which could otherwise be suitable vehicles for adoption. So, the nominal tax rate should be based on a typical mass-market HEV and applied to all automobiles. This is subjective, so a more thorough study of the market should be conducted to determine a representative average "mass market" HEV price, and this should be reviewed annually.
- 5.105 Table 5-3 provides a demonstration of the effect aligning mass market EV customs tax and VAT with HEVs could have. The total reduction would be approximately \$1,000 (and would be similar if the tax rates were aligned with ICE vehicles), which is a relatively small but not insignificant (9%) reduction compared to the current upfront cost of importing a typical EV (Nissan Leaf used in this example).
- 5.106 It should be noted, however, that these comparisons do not consider the capital costs of battery replacements for HEVs and EVs. Once this is considered, the tax reductions would represent approximately 5% of the total capital cost of EVs at present.

⁷⁹ Comparing a Ford Transit ICE van to a BYD T3 electric van. Total cost on import for the BYD T3 would reduce from around \$45,300 to around \$41,300

Table 5-3: Comparison of upfront costs when applying the nominal value of tax of mass market HEVs to EVs

Vehicle type	Vehicle case study used	Original vehicle cost (USD) ⁸⁰	Taxes (USD) ⁸¹	Total upfront cost (USD)
ICEV	Toyota Corolla	4,500	VAT: 670 Customs: 225 Excise: 2,000	~7,400
HEV	Toyota Prius '20	3,350	VAT: 520 Customs: 170 Excise: 1,700	~5,700
EV (with current customs tax and VAT)	Nissan Leaf	10,800	VAT: 1,160 Customs: 540 Excise: 230	~12,700
EV (with nominal taxes of a typical HEV)	Nissan Leaf	10,800	VAT: 520 Customs: 170 Excise: 230	~11,700

- 5.107 This may not be enough to persuade mass-market consumers on its own, but it could form part of a wider package of supportive measures to help make EVs more affordable.
- 5.108 For mid-level/new vehicles, the alignment in taxation, particularly if using the mass market example as the nominal tax value determinant, would be much more incentivising.

Key issues for implementation in the Mongolian context

- 5.109 Whilst this would not reduce the tax receipts the government currently receives from vehicle imports, it may reduce the potential tax receipts the government would have levied on EVs in the short-term. The reduced revenue on each vehicle import may be somewhat balanced by higher total EV imports, but it is likely it will be a net loss of potential revenue in the short-term. In the long-term, the price of EVs is likely to reduce relative to ICE vehicles and HEVs, bringing their tax revenues in line eventually, even if using a proportion of the vehicle cost.

⁸⁰ MSM (second hand vehicle import prices)

⁸¹ International Association of Movers. (2013). *CUSTOMS REGULATIONS AND INFORMATION FOR IMPORTS*. <https://s3.amazonaws.com/rdcms-iam/files/production/public/newimages/member/shippers/mongolia.pdf>

- 5.110 If the same nominal value is applied to all private automobile EVs, this would be a regressive tax, as the tax burden would be proportionally higher compared to income for those on lower incomes. To limit the impacts of the regressive nature of this tax for those on lower incomes, the nominal value should be based on a typical mass-market ICEV/HEV, rather than an average of the whole market.
- 5.111 It is also worth noting that the government cannot control importation taxes in other countries. So, for example, this incentive could not alter the import taxes at the Chinese border when importing an automobile from Japan via China. So, the import costs of EVs can't feasibly be completely aligned with ICEVs/HEVs by the government.

RECOMMENDATION D11: Develop Leasing Business Model for EVs



Private Automobiles



Light Freight



Urban Buses

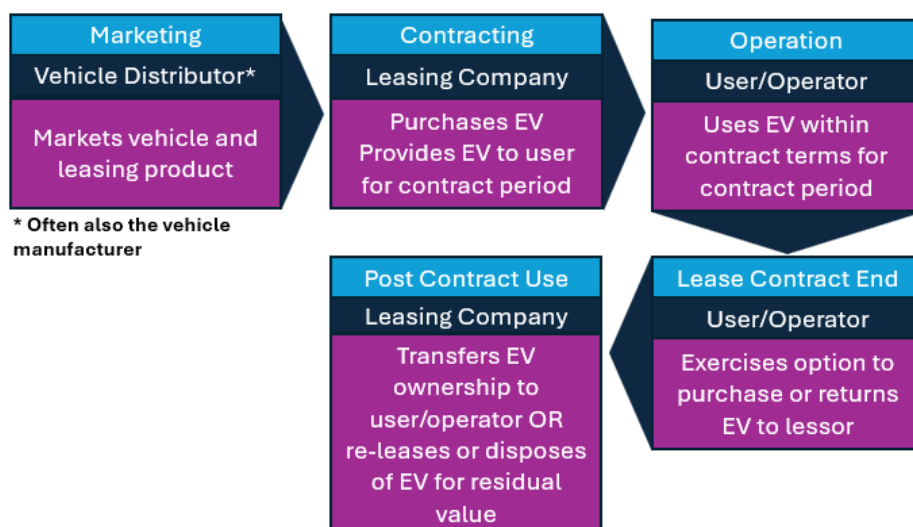


Taxis

Summary

- 5.112 EV leasing enables vehicle purchasers to mitigate higher capital costs and financing requirements of EVs, converting these into operating expenses. This is applicable in segments where the TCO of EVs is competitive with ICEs and HEVs. In Mongolia, this is particularly the case for high-usage light vehicles (taxis and light freight) where many owner-operators lack the financing capacity to purchase vehicles upfront. An overview of this model is shown in Figure 5-5 below.

Figure 5-5: EV private leasing model



- 5.113 The public sector should work with the private to develop a business model which is both profitable for lenders and affordable for fleet operators. This should include the development of the market in coordination with the development of the business model.

Implementation

- 5.114 The government could support the financing of the EV leases, e.g. through guaranteeing the loan repayments by fleet operators. The public sector could also help to develop the market for battery leasing. For instance, helping to bundle taxis, vans or buses into groups, so multiple operators can lease from one financier, who would then benefit from the economies of scale of leasing multiple vehicles at once.
- 5.115 The light freight segment would be the most viable segment in the short-term, given the relatively low upfront cost differential between EVs and ICE vehicles in this segment. The potential to make EVs affordable for operators where otherwise they would not be is greatest in the bus sector, with the highest upfront cost differential. However, this will also require significantly more financing and a good prospect of repayment of the loan for private financiers to consider this. So, this would likely only be feasible in the Proactive scenario in the medium- to long-term. The recommendation could be applied to the taxi segment in the medium- to long-term, as it becomes more formalised.

Key points for application in a Mongolian context

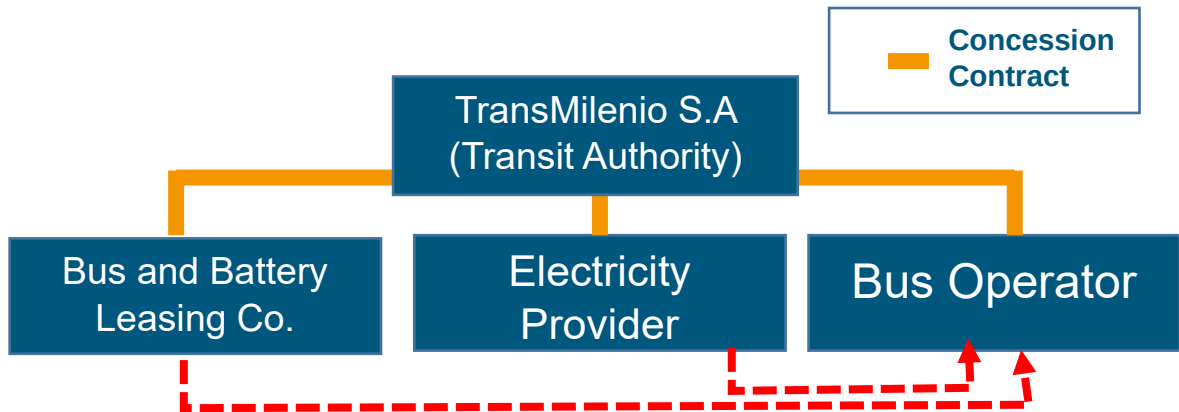
- 5.116 It should be noted that private financing rates for EV leases are likely to be high (if locally financed) or denominated in foreign currency (with exposure to long-term currency risk). While the Government has access to public borrowing rates (and even concessional climate financing), the extent to which the public sector enters the role of commercial vehicle financing needs to be a strategic decision.

Case Study: TransMilenio S.A.

- 5.117 Bogota's e-bus model is an example of how vehicles can be leased from a third-party private finance company to bus public transport operators, reducing the financial risk for them.
- 5.118 The private finance company buys and owns the electric buses and their batteries, which the public transport agency (TransMilenio S.A.) then leases using city funding, thus lowering the financial and long-term technological risk for bus operators from the purchasing of the assets. It also makes the payments more manageable for the public transport agency, spreading the cost over 15 years, rather than one large upfront cost.

- 5.119 The model enables TransMilenio S.A. to replace operators with relative ease if they do not provide the required level of service.

Figure 5-6: TransMilenio S.A. bus business model



- 5.120 In a similar arrangement, TransMilenio S.A. contracts out the provision and servicing of the charging infrastructure for the buses to a private energy company, although the chargers are installed at a publicly owned depot to reduce the performance risk. The cost of electricity is also paid on a monthly basis (by TransMilenio S.A. to the electricity provider) to make the costs more manageable.
- 5.121 Each operator concession contract is separately and competitively tendered, incentivising operators to innovate and find efficiencies.



- 5.122 The public transport agency uses separate accounts to remunerate each actor, allowing the service providers to focus on their area of expertise.

RECOMMENDATION D12: Develop Battery Leasing Mechanisms



Private Automobiles



Light Freight



Urban Buses



Taxis

Summary

- 5.123 The cost of the EV battery is separated out from the cost of the rest of the vehicle, with the vehicle purchased outright and the battery leased from a third party (or sometimes the vehicle manufacturer). The vehicle owner (or sometimes the operator, if not the same) pays the battery lease over the life of the asset, separately to whatever financing arrangement to purchase the vehicle.
- 5.124 This reduces the upfront capital cost (and financing requirement) and helps to mitigate the long-term performance risk of the battery. It also helps to manage EV battery waste through EV battery leasing companies. These companies will be able to trace the batteries under their ownership, and in turn the authority responsible for ensuring end-of-life batteries are disposed of correctly will be able to enforce legislation more easily through these companies.

Implementation

- 5.125 The battery leasing model has proven to be a commercially viable one, so the public sector should not be required to provide a financing role to support the incentive. However, there may be efforts required to ensure battery leasing companies are able to enter the market smoothly, but also regulations in place to ensure the business is conducted fairly and in a responsible manner. For instance, legislation needs to be in place to determine what happens when a battery is damaged in a collision, what consumers' rights are concerning around battery performance, who is responsible for disposing of the battery at the end of its life, what happens to the battery if the battery leasing company folds, etc.
- 5.126 This model is only suitable for new vehicle segments, where the battery can be leased over 5+ years, and will work best as an incentive for segments where the EV TCO is comparable to that of ICE/HEV equivalents, but the capital cost is much higher for EVs. This applies to most segments, except for light freight, which has a lower TCO and comparable capital cost for EVs as ICE vehicles. However, light freight operators may still appreciate the opportunity to make the purchase of vehicles more manageable, so this is still recommended for this segment.

Key points for application in Mongolian context

- 5.127 The dominance of used vehicle imports to Mongolia would be a major barrier, particularly in the private automobile segment. This will significantly limit the reach of this incentive. The segment with the most potential in the short-term is the bus segment, given it is the segment with the highest proportion of new vehicle imports, often procured in batches.
- 5.128 The informality of the taxi sector at present would make this hard to implement, partly due to the fragmented nature of the sector, meaning that thousands of separate lease agreements would need to be formed with individual taxi owner-operators. The more significant issue, however, would be the difficulty in ensuring the batteries being leased were for the purposes of a taxi and not for personal use. It would also make innovative ideas like using old taxi batteries as BESS for fast-charging EV taxis during the day much harder to implement.
- 5.129 Therefore, the taxi sector needs to be significantly more formalised than it is at present for this to be a viable option, which may be a possibility in the medium- to long-term, but not the short-term.

Case study: Hyundai battery leasing, South Korea

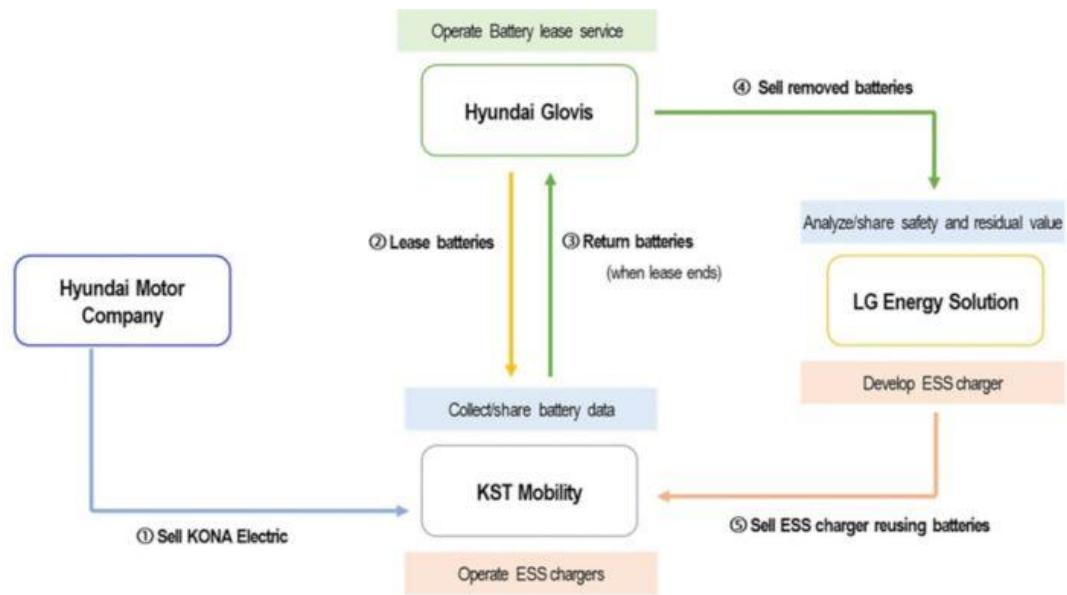
- 5.130 South Korean automobile manufacturer Hyundai has entered a battery leasing arrangement with a taxi operator, KST Mobility, with the support of the South Korean Ministry of Trade, Industry and Energy, alongside LG Energy Solution⁸².
- 5.131 The Memorandum of Understanding (MOU) signed by the parties sets out a plan for KST Mobility, the taxi operator, to purchase the Hyundai vehicles (excluding the battery) upfront but make monthly payments for the battery to Hyundai's battery lessor company, Hyundai Glovis⁸³. This helps to lower the initial capital investment for the taxi company, making the cost of the EVs more manageable.

⁸² Morton, R. (2021, September 30). *Battery-As-A-Service starts to catch on*. Fleet & Leasing.

<https://www.fleetandleasing.com/fleet-management/battery-as-a-service-starts-to-catch-on/>

⁸³ *Hyundai signs MOU for EV battery lease to foster EV ecosystem*. (n.d.). <https://www.hyundai.news/eu/articles/press-releases/hyundai-signs-mou-for-ev-battery-lease-to-foster-ev-ecosystem.html#:~:text=Under%20the%20agreement%2C%20KST%20Mobility,initial%20investment%20for%20EV%20purchase%20>

Figure 5-7: Hyundai battery leasing model with KST Mobility taxi firm



Source: Hyundai

- 5.132 Once the batteries have reached the end of their operational life, they are purchased and analysed by LG Energy Solution to assess their safety and residual value. LG then sells suitable batteries back to KST Mobility and installs the batteries as Battery Energy Storage Systems (BESS)⁸³. This allows the taxi company to store cheaper electricity overnight to recharge its EV taxis with during the day.
- 5.133 The Ministry of Trade, Industry and Energy actively facilitated this business model⁸³.

RECOMMENDATION D13: Reduced Licensing Fees for Taxi Operators



Private Automobiles



Light Freight



Urban Buses



Taxis

Summary

- 5.134 Taxi companies with a minimum proportion of EVs in their fleet are able to purchase licenses for areas of operation for a reduced fee. This would reduce operational costs for taxis to help balance the higher capital costs of EV purchases. As the capital cost differential between EVs and HEV/ICEVs is quite high for standard taxis, taxi operators will need a range of 'nudges' like this to incentivise them to adopt EVs.

- 5.135 BEBs are largely procured by the MUB PTD, given the difficulties private operators have financing bus purchases, so it would be unfair to base an incentive on this for PT operators.

Implementation

- 5.136 The MUB PTD controls the licensing of formal taxi operation in Ulaanbaatar. The proportion of EVs in a fleet for operators to be eligible for reduced licensing fees can be steadily increased over time as EVs become more popular. In the short-term, this minimum threshold should be set to a low level, given that no formal taxis currently operating in Ulaanbaatar are electric, according to the MUB PTD.

Key points for application in Mongolian context

- 5.137 In order for this incentive to have a broad reach, the segment will need to be formalised. Informal operators will not benefit from reduced licensing fees as they do not work under licenses. Therefore, this incentive will be more effective in the medium- to long-term as the sector becomes more formalised. It can be introduced in the short-term to incentivise existing taxi operators to adopt EVs, but its impact will be limited and the minimum proportion of EVs in a fleet will have to be set to a low level to begin with.

Case study: Cambridge, UK

- 5.138 Cambridge City Council introduced a number of incentives and EV adoption ambitions in 2018 to encourage taxi operators to switch to EVs⁸⁴, including:
- A **licence fee exemption** for zero emission vehicles from 1 April 2018.
 - A **licence fee discount** for ultra-low emission vehicles from 1 April 2018.
 - An extended age limit for zero emission vehicles from 1 April 2018 (from 8 years for ICEVs to 15 years for EVs).
 - An extended age limit for ultra-low vehicles from 1 April 2018.
 - A set date for all *new* Licensed Saloon Vehicles to be ultra-low or zero emission from 1 April 2020.
 - A set date for all Licensed Saloon Vehicles to be ultra-low or zero emission from 1 April 2028.

⁸⁴ Cambridge County Council. (2021). *Electric Vehicle Taxi transition*. <https://www.local.gov.uk/case-studies/electric-vehicle-taxi-transition>

- To restrict city centre access to only ultra-low and zero emission licensed vehicles by December 2028.

5.139 This was supported by significant fiscal investment in charging infrastructure across the city⁸⁴.

6. EV Technology Recommendations

Optimising E-Mobility for Mongolian Winter

Whilst extreme cold is not a barrier to EV technology in Mongolia overall, various solutions can support and accelerate the EV transition as outlined below.

RECOMMENDATION S1: Promoting Cold-Weather EV Performance Optimisation Practices by EV Owners and Users

- 6.1 As outlined in the E-Mobility Assessment and Readiness Analysis, many of the cold weather challenges encountered in other contexts can be prevented or mitigated through user behaviour and practices. While these are short-term issues which will reduce as users become more accustomed to the technology, active user education can smooth the EV transition process and prevent negative perceptions of EVs resulting from this. Key topics include:

EV pre-heating before driving:

- **Addresses:** Reduced Range; Charging Issues.
- 6.2 Vehicle pre-heating before use helps to maintain the battery's efficiency and performance, ensures the comfortable cabin temperature (before driving), as well as improving the charging of vehicles. This pre-heating process can be done in two ways: i) by using a car charger powered by grid supply and ii) by using the battery as an energy source. The former method is preferred for pre-heating, typically for 15-20 minutes⁸⁵ prior to driving.
- 6.3 Pre-heating of EVs is common and used in many cold climatic conditions globally (e.g. Norway, Canada, Chicago, etc.). As described, cold climatic conditions can also affect EV fast charging performance. For instance, in the American Midwest, Tesla EV owners reported being unable to charge their vehicles during extremely cold weather. However, those who had undertaken pre-heating were able to charge their vehicles⁸⁷.
- 6.4 Pre-heating also helps to reduce the negative impacts of cold ambient temperatures on driving range and battery longevity by raising the battery temperature to its

⁸⁵ Sørensen, Å. L., Ludvigsen, B., & Andresen, I. (2023). Grid-connected cabin preheating of Electric Vehicles in cold climates – A non-flexible share of the EV energy use. *Applied Energy*, 341, 121054. <https://doi.org/10.1016/j.apenergy.2023.121054>

⁸⁶ There can be some inconvenience for drivers as they will need to start preparing for their journey 20-30 mins before they leave for driving.

⁸⁷ McGowan, E. (2024, January 17). The bitterly cold temperatures are causing Tesla graveyards across the Chicago area. *Secret Chicago*. <https://secretechicago.com/chicago-winter-causing-tesla-graveyards/>

optimal range. Pre-heating can cause some battery wear due to uneven heating of the battery⁸⁸⁸⁹, but this is outweighed by the benefits of mostly avoiding the damage that would have been caused by attempting to charge the battery below its optimal temperature⁹⁰⁹¹.

- 6.5 **Applicability to Mongolia:** Pre-heating is primarily applicable to cars in the country. For example, old Toyota Prius owners in UB often use block heaters⁹² to preheat their engines and batteries before driving. This approach should be proposed to EV users in Mongolia. Pre-heating is also possible for e-buses in Mongolia while they are being charged overnight typically at depots.

Prioritize Slow Charging

- 6.6 Slow charging of EVs helps maintain a moderate battery temperature, thereby minimising stress and promoting a longer lifespan for the battery's State of Health (SoH). This gradual charging process is especially advantageous during winter months, when temperatures not only affect fast charging performance but can put additional strain on the battery in cold weather leading to accelerated degradation.
- 6.7 **Applicability to Mongolia:** For EV consumers, slow charging (overnight, destination) should be promoted to maintain EV performance during winter. The co-benefits of reduced battery degradation may also support promotion of this practice. This should be taken into account for the development of EV fleets (public and private), with overnight slow charging for e-buses, for example. The use of covered areas (ideally) for charging is also good practice, and in line with most ICE fleet depots in Mongolia.

Promote EV smart technology options to facilitate good practice

- 6.8 Recent advancements in both hardware and software have enhanced the functionality, efficiency, and user experience of EVs. Hardware innovations include battery blankets, low-voltage electrical systems for seat and steering heating, and improved energy

⁸⁸ Wu, S. et al. (2020). The state of the art on preheating lithium-ion batteries in cold weather. *Journal of Energy Storage*, 27. <https://doi.org/10.1016/j.est.2019.101059>.

⁸⁹ Hu, X. et al. (2020). Battery warm-up methodologies at subzero temperatures for automotive applications: Recent advances and perspectives. *Progress in Energy and Combustion Science*, 77. <https://www.sciencedirect.com/science/article/pii/S0360128519301169#sec0028>

⁹⁰ Zhu, Tao & Min, Haitao & Yu, Yuanbin & Zhao, Zhongmin & Xu, Tao & Chen, Yang & Li, Xinyong & Cong, Zhang. (2017). An Optimized Energy Management Strategy for Preheating Vehicle-Mounted Li-ion Batteries at Subzero Temperatures. *Energies*. 10. 243. 10.3390/en10020243.

⁹¹ There is limited empirical data to determine the exact impact of cold temperatures on EV battery longevity when pre-heating and battery temperature management technologies are used. However, at the strategic level of this study, there is no evidence from cold climatic countries that have more advanced EV adoption to suggest the longevity of batteries is affected to a point that it would discourage prospective EV buyers from owning an EV. Therefore, the modelling in this study assumes no substantial change to average battery lifespans.

⁹² Development Asia. (2019). *How Block Heater Technology Can Reduce Carbon and Air Pollution*. <https://development.asia/explainer/how-block-heater-technology-can-reduce-carbon-and-air-pollution>

management systems. Software developments provide real-time data to optimize charging efficiency and remote control of battery preheating⁹³. For example:

- Battery blankets can be used while the EV is parked to keep the battery in prime condition. This technology, developed by researchers at Shanghai Jiao Tong University in China⁹⁴, is particularly useful for maintaining battery performance in extreme cold.
- Vehicle manufacturers mobile apps (e.g. Tesla's Trip Planner, the NissanConnect EV app for the Nissan Leaf, BMW's ConnectedDrive Services and others) allow users to remotely control functions such as cabin heating and pre-heating the battery while charging.
- Many EV models such as Hyundai Kona, Tesla Model 3, Ford EV Vans, Kia Niro, etc. offer features like seat and steering heating which utilizes significantly less energy to generate heat than systems in older EV models, and therefore has a lower impact on vehicle range.

6.9 **Applicability to Mongolia:** Many of these advanced features are not exclusive to high-end vehicles but are also available in mid-range compact cars (e.g. Hyundai, Kia, and others). As these features become increasingly prevalent, they may eventually become commonplace in the Mongolian mass market in the future.

RECOMMENDATION S2: Encourage Importation of EVs with Heat Pumps

- 6.10 Integrating heat pumps in EVs is a key step towards enhancing their overall efficiency. Heat pumps extract heat from the outside air and transfer it inside the vehicle, making them more energy-efficient compared to traditional resistive heaters, such as Positive Temperature Coefficient (PTC) heaters, which directly convert electrical energy into heat using a blower.
- 6.11 A 2022 literature study⁹⁵ highlighted that at -7°C, using a traditional PTC heater resulted in a total range loss of 42.8%, with 26.4% of this loss attributed to resistive heating alone, while the remainder was due to reduced battery performance and

⁹³ Wallbox. (2021, June 30). *What do protection ratings mean?* New. <https://blog.wallbox.com/what-do-protection-ratings-mean/>

⁹⁴ Cuff, M. (2023, July 19). Blanket for electric cars helps preserve battery performance. *New Scientist*. <https://www.newscientist.com/article/2381990-blanket-for-electric-cars-helps-preserve-battery-performance/>

⁹⁵ Zhao, C., et al. (2022). Research on electric vehicle range under cold condition. *Advances in Mechanical Engineering*, 14(3), 168781322210870. <https://doi.org/10.1177/16878132221087083>

- drivetrain efficiency. In contrast, using a heat pump showed a ~30% reduction in energy consumption, leading to a 7.9% increase in range compared to the PTC heater⁹⁶.
- 6.12 It should be noted, however, that the effectiveness of heat pumps decreases as temperatures decrease below the battery's optimal operating temperature⁹⁷. Empirical evidence is limited for the efficacy of heat pumps of EVs in extremely low temperatures, and heat pump technology is improving, but currently it would seem heat pumps become ineffective at temperatures below approximately -10°C^{95,96,98}. This would apply in Mongolia between November and February, when average mean surface air temperatures are below -10°C⁹⁹. EVs with heat pumps would still be operational in these months, but their range would be similar to that of EVs with resistance heaters.
- 6.13 For much of the year when temperatures are above -10°C, heat pumps will help to improve EV range in Mongolia by regulating battery temperatures. This applies not only when external temperatures are low, but also during warmer summer months when heat pumps can also provide a cooling effect, thereby reducing the impact of cold temperatures on battery longevity⁸⁹.
- 6.14 Hyundai Kona Electric has made it standard to equip the vehicle with a heat pump, which allows it to retain 84% of its original estimated range during winter. Whereas Volkswagen ID4 which is not equipped with heat pump, instead with heated seats and steering wheel, achieves only 65% of its rated range.
- 6.15 **Applicability to Mongolia:** At present, Mongolia imports older EV models (e.g., Prius models over 8-10 years old) lack heat pumps, underscoring the necessity to mandate that imported EVs include this feature. Recent EV models like the BYD Atto 3, Hyundai Kona, Nissan Leaf, Kia Niro, among others, are already equipped with heat pumps.
- 6.16 The Government should work with EV distributors to ensure vehicle models with heat pumps are imported to Mongolia wherever possible. It would not be proportionate to impose a ban on vehicles without heat pumps, but they should be strongly encouraged, and prospective EV purchasers informed of their benefits.

⁹⁶ Li, K., et al. (2021). Investigation on the performance and characteristics of a heat pump system for electric vehicles under extreme temperature conditions. *Case Studies in Thermal Engineering*, 27, 101308. <https://doi.org/10.1016/j.csite.2021.101308>
⁹⁷ <https://www.recurrentauto.com/research/heat-pumps> Heat Pump Saves Range Graph

⁹⁸ Marshall, A., & Simon, M. (2024, January 19). How the Mighty Heat Pump Helps EVs in Cold Weather. *WIRED*.
<https://www.wired.com/story/heat-pump-helping-but-not-solving-ev-cold-weather-problem/#:~:text=There%20isn't%20a%20huge,miles%E2%80%94lost%20in%20cold%20weather.&text=Even%20with%20these%20new%20advances,t%20a%20heat%20pump's%20friend.>

⁹⁹ World Bank Climate Change Knowledge Portal. (n.d.-b).
<https://climateknowledgeportal.worldbank.org/country/mongolia/climate-data-historical>

RECOMMENDATION S3: Ingress Protection (IP)/Impact Protection (IK) for EV Charging Infrastructure

- 6.17 IP and IK are standardized measures established by the International Electrotechnical Commission (IEC). An IP rating signifies the degree of protection an electrical device offers against dust and water ingress, crucial for ensuring functionality in cold climates characterized by heavy snowfall and ice. An IK rating gauges the level of mechanical impact protection provided by an enclosure, essential in cold climates where heavy snow and ice can induce physical stress.
- 6.18 **Applicability to Mongolia:** Mongolia's harsh winters present challenges to EV charging infrastructure. While the IEC standard recommends an IP rating of 54 (protection against dust, dirt, and light water sprays), Mongolia's extreme weather demands a higher level of toughness up to IP 65 (protection against sustained water jets, dust) and IK 10¹⁰⁰ or higher (resistance to impact) to survive heavy snowfall for its continuous functioning. These standard requirements in setting up charging stations can improve reliable EV charging experience in the country. Additionally, the country can also consider implementing National Electrical Manufacturers Association (NEMA) certifications¹⁰¹, which are used by independent testing laboratories to assess the EV charger safety and ability to withstand various environmental threats globally. NEMA is more focused towards electrical safety standards, including corrosion, ice formation, dust circulating, etc. tests for EV chargers.

¹⁰⁰ CITA EV Charger. (2024, February 9). *What are IP65 & IK10 Ratings? What does it mean for EV Chargers?*
<https://www.linkedin.com/pulse/what-ip65-ik10-ratings-does-mean-ev-chargers-citaevcharger-3110c/>

¹⁰¹ Rittal. (2023). *IP or NEMA: Which Enclosure Rating is More Important When Designing Electric Vehicle Charging Stations?*
 Market Update. https://www.rittal.com/us-en_US/Company/Rittal-Stories/IP-or-NEMA--Which-is-Best-for-EV-Charging-Stations

EV transition in cold climates case studies

Norway

- 6.19 Norway has achieved an EV market share of 65% of EVs¹⁰² within the last decade, despite winter temperatures similar to Ulaanbaatar (as low as -30°C). In January 2022, the Norwegian Automobile Federation (NEF)¹⁰³ conducted a study to investigate the effect of cold climatic

Figure 6-1: On-street charging in extremely cold conditions



- conditions on 31 EV models, finding that they lose between 4% to 30% of their Worldwide Harmonized Light Vehicles Test Procedure (WLTP)¹⁰⁴ range in cold climatic conditions. They also stated that colder climatic conditions affect the charging speed of EVs.
- 6.20 Key aspects of Norway's approach to promote EV technology in these climate conditions include:
- Establishing a robust charging station network, which has helped to ease the concerns of EV owners regarding the availability of charging infrastructure.
 - Promoting overnight EV charging at home¹⁰⁵, with vehicles sheltered in a garage or shed. This not only improves the efficiency of a battery's charging but can also extend its lifespan.
 - Passing a law granting charging rights for apartment residents, ensuring that residents can install charging infrastructure in shared communal parking areas.
 - Roll-out of on-street parking in residential areas with EV charging stations for multi-family homes without personal parking. This type of charging is suitable for EV owners who do not have access to private charging facilities. It offers a convenient option for slow overnight charging, allowing EV owners to book slots as

¹⁰² Raaum, P., & Monn-Iversen, Ø. A. (2022, February 4). Motors store vintertest av rekkevidde på elbiler. *Motor.no*. <https://www.motor.no/aktuelt/motors-store-vintertest-av-rekkevidde-pa-elbiler/217132>

¹⁰³ Raaum, P., & Monn-Iversen, Ø. A. (2022, February 4). Motors store vintertest av rekkevidde på elbiler. *Motor.no*. <https://www.motor.no/aktuelt/motors-store-vintertest-av-rekkevidde-pa-elbiler/217132>

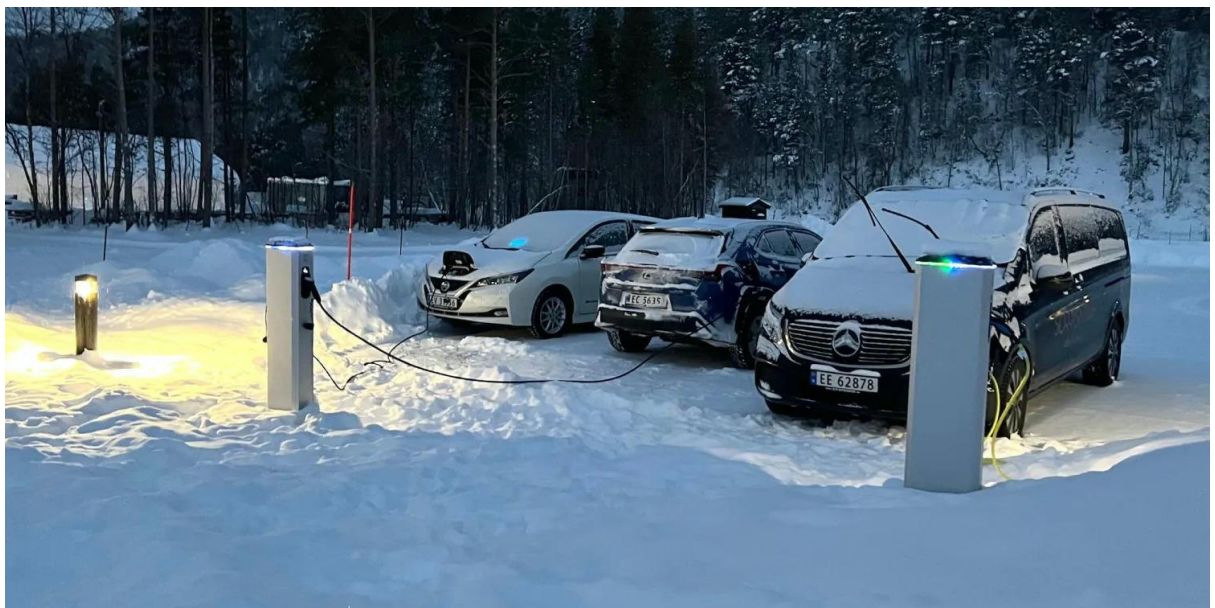
¹⁰⁴ Octopus Electric Vehicles. (2024, May 8). Everything you need to know about WLTP. <https://octopusev.com/ev-hub/what-is-wltp-how-does-it-work>

¹⁰⁵ Toussaint, K. (2024). EVs work fine in the cold in Norway. Here's how they do it. <https://www.fastcompany.com/91011373/evs-work-fine-in-the-cold-in-norway-heres-how-they-do-it>

needed¹⁰⁶. Although this charging method is exposed to cold climate conditions, it remains in use due to the benefits of slow charging (relative to fast charging), even in such environments.

It should be noted that the availability of garages in Ulaanbaatar, where an EV charging network could feasibly be installed, is much lower than in Norway, with no covered parking in many (particularly older) residential blocks. Alternatively, for private cars, Mongolia could consider establishing charging stations near owners' premises, similar to the approach seen in Norway.

Figure 6-2: On-street EV charging in Norway



Canada

- 6.21 Although Canada has not seen the same rapid uptake of EVs as Norway, this is more a result of government legislation than concerns of the technological challenges of extreme cold conditions. Norway announced that all new cars sold by 2025 should be zero-emission in 2017¹⁰⁷. In contrast, Canada has only mandated that a fifth of EV sales should be zero-emission by 2026, with 100% zero-emission sales only required by

¹⁰⁶ Norsk elbilforening. (2023, September 12). *Norwegian EV policy - Norsk elbilforening*. Norsk Elbilforening.

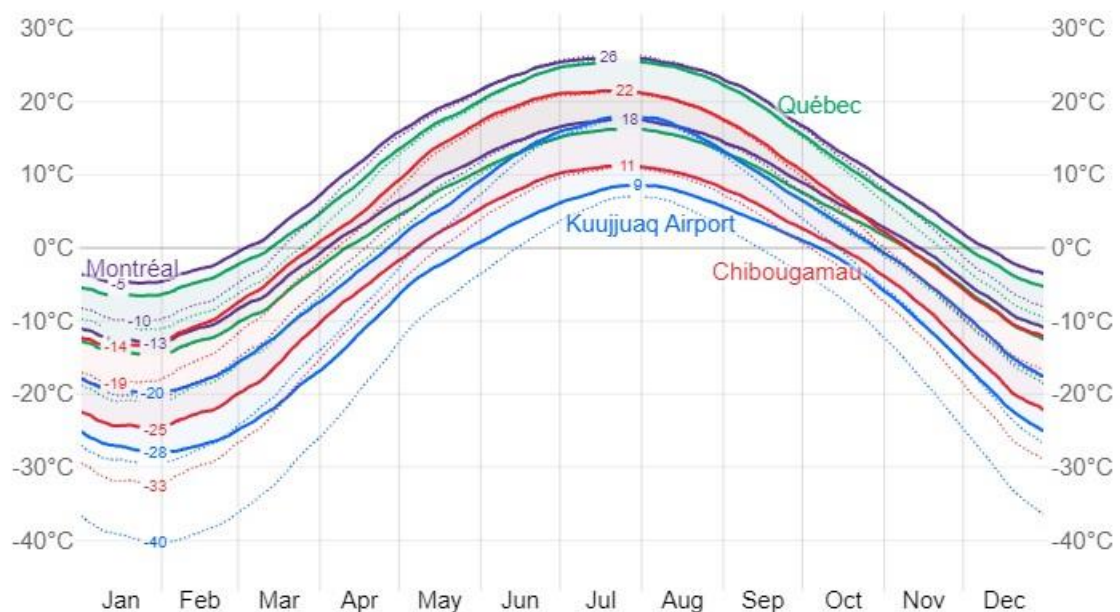
<https://elbil.no/english/norwegian-ev-policy/#:~:text=The%20Norwegian%20Parliament%20decided%20on,applies%20to%20city%20buses%E2%80%8B>

¹⁰⁷ Incentives and legislation | European Alternative Fuels Observatory. (2024). <https://alternative-fuels-observatory.ec.europa.eu/transport-mode/road/norway/incentives-legislations#:~:text=The%20Norwegian%20Parliament%20decided%20on,applies%20to%20city%20buses%E2%80%8B>.

2035¹⁰⁸. With the lack of impetus to adopt EVs in the short-term, just over 10% of new vehicle sales in Canada were electric in 2023.

- 6.22 However, in provinces that set zero-emission sales targets earlier than at the federal level, uptake has already exceeded the 2026 federal targets. According to Statistics Canada, 20% of new cars in Quebec and 25% of new cars in British Columbia were electric¹⁰⁹. As shown in Figure 6-3 below, Quebec has some of the harshest winters of the more densely populated provinces in Canada¹¹⁰, and is comparatively closer to Ulaanbaatar's climate than Norway. The fact that Quebec, even in rural areas¹¹¹, has a high rate of EV uptake for Canada clearly demonstrates that political ambition and support has a major influence upon EV adoption. The evidence suggests that, whilst the climate does pose technological challenges, drivers have not been put off purchasing EVs due to climate concerns.

Figure 6-3: Quebec Province's average temperatures



Source: Weather Spark

- 6.23 As found in Norway, EV ranges do reduce in winter. The Canadian Automobile Association (CAA) estimates that EV ranges decrease as much as 40-50% in

¹⁰⁸ Cecco, L. (2023a, December 19). Canada to require all new cars to be zero-emission by 2035. *The Guardian*. <https://www.theguardian.com/world/2023/dec/19/canada-car-emissions-automaker-electric-2035>

¹⁰⁹ Cecco, L. (2023b, December 19). Canada to require all new cars to be zero-emission by 2035. *The Guardian*. <https://www.theguardian.com/world/2023/dec/19/canada-car-emissions-automaker-electric-2035>

¹¹⁰ Quebec climate, weather by month, Average temperature (Canada) - Weather Spark. (n.d.). Weather Spark. <https://weatherspark.com/countries/CA/10>

¹¹¹ Allan, T. (2024b, February 13). Turning down the dial on cold weather anxiety for EVs in Canada. Electric Autonomy Canada. <https://electricautonomy.ca/policy-regulations/opinions/2024-02-13/cold-weather-ev-anxiety-canada/>

temperatures below -15°C, although this may be less severe if the battery heater is given time to work¹¹². However, the effect on charging times is minimal. A study of over 4,000 Tesla Model 3s found that charging times were only nine minutes longer at -18°C than at warmer temperatures¹¹¹.

6.24 Similar to Norway, practices being used by drivers to mitigate the impact of the extremely cold winters include¹¹¹:

- Pre-heating vehicle cabins while charging
- Planning more range in reserve for journeys
- Pre-conditioning batteries before using fast-charging stations
- Planning trips with EV charging network apps to ensure charging stations are online before departing

Existing EV charging standards

6.25 Mongolia has already developed an EV Charging Station standard, MNS 6758:2019. This standard outlines the general requirements for the types of EV charging stations, cables/connectors, plugs, charging modes, and the installation and placement of charging station equipment. It was developed in alignment with some of global charging standards of International Electrotechnical Commission (IEC) such as:

- IEC 62196 – defines the design of plugs, sockets, vehicle connectors, and inlets for EV charging, including operating voltage, safety features, durability, weather resistance and others
- IEC 61851 – defines EV conductive charging systems and provides four modes of charging, each defined within a specific power rating range
- IEC 60529 – defines "Ingress Protection" (IP) ratings for electrical equipment, indicating protection against contact, foreign objects (e.g. dust, etc.), corrosion resistance, and water ingress under various environmental conditions
- IEC 62262 – defines "Impact Protection" (IK) ratings for electrical equipment housings against mechanical/ collisions impacts

6.26 It is to be noted that all IEC charging standards are not included in the existing standard, limiting the safety and performance of charging stations. Without comprehensive standards in place, there is an increased risk of potential hazards associated with charging infrastructure, which could also undermine EV user

¹¹² *What challenges do Canadians face moving to a fully integrated EV future?* (2024, January 20). CTVNews. <https://www.ctvnews.ca/autos/what-challenges-do-canadians-face-moving-to-a-fully-integrated-ev-future-1.6733696>

confidence in the safety of EV charging facilities. To address this, it is recommended that the country needs to amend or modify its existing EV charging standard by including the following standards:

- **IEC 61000 – Electromagnetic Interference / Compatibility of EVs and Charging Stations**

- **Description** - This standard provides guidelines for electrostatic discharge (ESD), surge, magnetic field, and radiofrequency (RF) interference testing in both EVs and EV charging stations. These standards ensure that EVs and charging stations are resilient to ESD events, voltage surges, magnetic interference, and RF emissions, safeguarding their electronic systems and ensuring reliable operation.
- **Benefits** - Adherence to IEC 61000 standard helps to mitigate electromagnetic interference (EMI) issues, ensuring that charging stations do not produce electromagnetic emissions that could disrupt the operation of nearby electronic devices or systems. This is particularly important in densely populated urban areas (like Ulaanbaatar) where multiple charging stations may be installed in close proximity to residential or commercial buildings. Also, it defines immunity requirements for EV charging stations ensuring that they can withstand electromagnetic disturbances from external sources such as power lines, radio frequency interference, or lightning strikes. By adhering to these standards, charging stations are better equipped to maintain reliable operation in diverse environmental conditions, including those with high levels of electromagnetic interference.

- **IEC 60068 – Environmental Testing of Electronic Equipment**

- **Description** – This standard provides methods for environmental testing of electronic equipment, components and electromechanical products to assess their ability to perform and survive under conditions such as transportation, storage, operational environments, extreme cold and heat.
- **Benefits** – The IEC 60068 tests provide substantial advantages, particularly for countries with extreme climates such as Mongolia. In frigid areas where temperatures may go below 0°C, the 'Cold Test' guarantees that equipment functions efficiently even in ambient temperatures as low as -40°C¹¹³. It also ensures that the product (i.e. charger) performs well in other conditions such as heat, damp heat, etc.

¹¹³ Electrical Safety Testing Laboratory. (2022, July 22). *IEC 60068- Environmental Conditioning – Electrical Safety Testing Laboratory*. <https://www.itcindia.org/iec-60068-environmental-conditioning/>

RECOMMENDATION S4: Update EV Charging Stations Standards & Safety Requirements

- **Inclusion of additional/remaining parts of IEC 62196**
 - **Description** – This standard has several parts of which Mongolia is following initial 3 parts and requires updating to incorporate the provisions outlined in parts #4 and #6 of IEC standards. Part #4 focuses on enhancing digital communication between Electric Vehicle Supply Equipment (EVSE) and EVs, enabling interchangeability/ interoperability for different EV models. On the other hand, part #6 prioritizes the development of charging stations suitable for environments posing potential hazards, such as those with flammable gases, vapours, or combustible materials.
 - **Benefits** – Compliance with the additional parts of this standard will provide essential safeguards against electric shock by implementing double or reinforced insulation and electrical separation methods. This inclusion is important for ensuring safe charging practices, especially in locations near petrol pumps, industrial settings, and other areas in Mongolia where there could be risk of fuel leakage. Also, the standard's emphasis on interchangeability ensures that EVs can seamlessly charge from either AC or DC charging guns, enhancing user experience and contributing to the growth of the EV market.
- **Inclusion of Open Charge Point Protocol (OCPP) standard**
 - **Description** – The Open Charge Point Protocol (OCPP) is a standard developed by the Open Charge Point Alliance (OCPA) that ensures interoperability between charging hardware (charging stations) and software (Charging Management Software). This protocol allows different brands and models of charging stations to communicate seamlessly with various software systems, enhancing flexibility and compatibility across the EV charging infrastructure.
 - **Benefits** – The OCPP offers numerous benefits for Charge Point Operators (CPOs). It enables CPOs to configure and monitor public charging stations efficiently, ensuring optimal operation through load-balancing and streamlined charging authorisation and billing processes. CPOs have the capability to control access to chargers and set specific user parameters, enhancing security and user management. Additionally, OCPP facilitates communication by sending critical information messages to users, ensuring they are well-informed about the charging status and any important

updates. This comprehensive functionality helps CPOs maintain high service standards and improve user experience.

- **Inclusion of Chinese GB/T standard**

- While the country has been importing EVs predominantly from Japan, recently in last few years there has been an increasing number of EVs being imported from China. Assuming that the imports from China will continue to increase, it is reasonable to consider the incorporation of GB/T standards (China national standards, also called as Guobiao Standards) into the existing standard. Currently, the standards do not explicitly specify whether the inclusion of GB/T standards is permitted or not. Alternatively, there are converters also available that convert other standards such as CCS2 to GB/T (e.g.¹¹⁴) and can be included in the charging standard.

- **Inclusion of additional safety standards**

- The charging standards currently in place do not account for additional safety standards between EVs and EVSE. Specifically, IEC 62752, addressing in-cable control and protection devices for mode 2 charging of road EVs, is not integrated into the current standards. Also, IEC 62955, concerning residual direct current (RDC) detecting devices for use in mode 3 charging of EVs, is not incorporated within the standard. These standards can be included for ensuring better safe operations of charging stations.

¹¹⁴ CCS2 to GBT EV charging Adapter 200A 1000V DC CCS2 Combo GB/T Convertor Adapter fit for GBT DC car - AliExpress 34. (n.d.). Aliexpress. <https://www.aliexpress.com/item/1005003933094819.html>

7. Energy Sector Recommendations

Introduction

- 7.1 As demonstrated in the scenario modelling, e-mobility will have impacts upon electricity demand and grid infrastructure. While the most optimistic EV deployment scenario projects that this will be limited to 1.9% of overall demand, this is likely to contribute to pressures on aging and over loaded distribution networks. Furthermore, the extent to which EVs support decarbonisation goals also depends on the ability to reduce the carbon emissions used for EV charging, for which both off-grid RE generation and wider grid decarbonisation are likely to play a role.
- 7.2 These recommendations are broken down into two sections:
- Grid planning and infrastructure, looking at the hardware and software solutions which can be promoted to address these issues.
 - Economic regulation and investment related recommendations, including EV charging tariffs and RE integration.

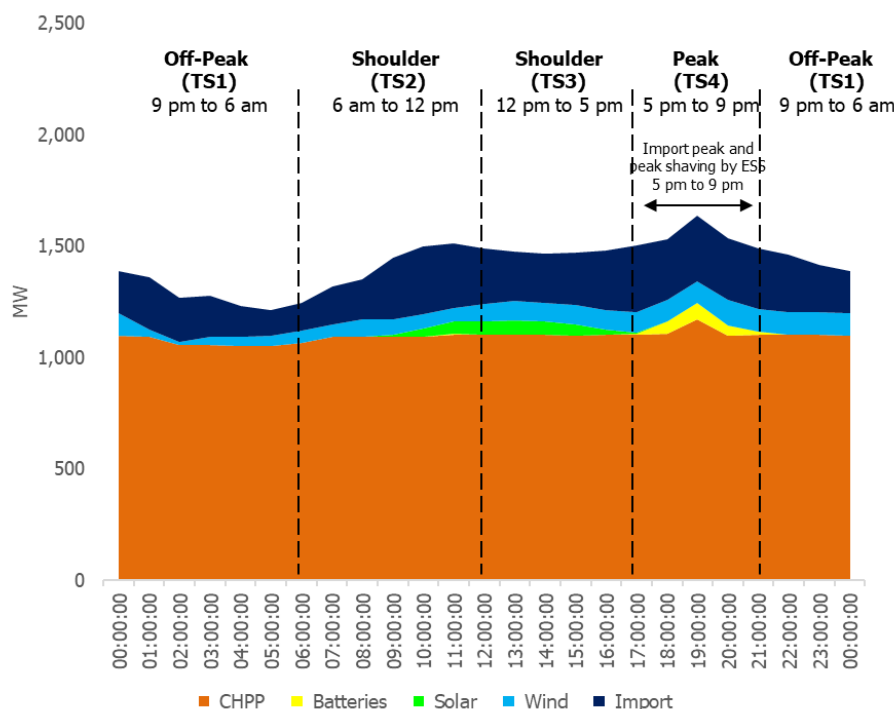
Grid Planning and Infrastructure

Grid management context

- 7.3 As shown in Figure 7-19 the peak load for the CES region during the winter of 2023 was around 1,636 MW, with the load curve segmented into four distinct time slots (TS1 to TS4), with two peaks (TS2, TS4) and one off-peak period (TS1). During the winter season, the country exhibits significant dependence on electricity imports across all time slots. Russia serves as the primary supplier of electricity imports, and Mongolia also uses energy storage solutions (ESS)¹¹⁵ address peak demand, particularly during evening hours (TS4). Peak load in the summer) of the CES region as of 2023 is around 1,039 MW, 36% lower than peak demand in winter.
- 7.4 During the late night hours (after 1 am) to morning hours (till 8 am) as shown in Fig 7-19, Mongolia does not rely on electricity imports. Instead, it exports excess energy generated during this period to Russia at a significantly lower price, reported to be one-eighth of the import price.

¹¹⁵ As per the load curve data received from NDC

Figure 7-1: Average load curve in 2023 for CES region (winter) without EV load



Source: National Dispatching Center (NDC), Mongolia

- 7.5 From an infrastructure perspective, recommendations seek to address the key challenges in Mongolia summarised in Table 7-1.

Table 7-1: Grid planning & infrastructure challenges and recommendations

Challenge	Summary Description	Proposed Solution
Collective impact on the already increasing electricity demand in Mongolia	Mongolia's electricity demand is increasing significantly, already the peak is going above the countries generation limits, resorting to expensive electricity imports from neighbouring countries. The peak demand occurs between 5pm – 11 pm, this consequently coincide with home charging, public charging and e-bus depot charging patterns.	Recommendation S5 and S9

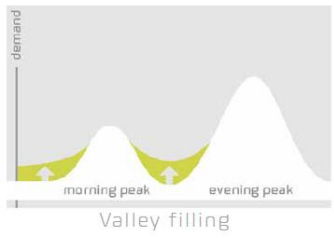
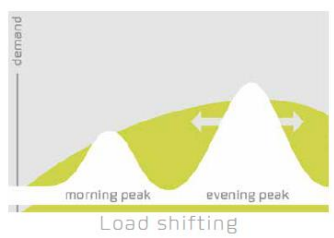
High emission factors for EV's due to a highly coal powered electricity generation.	The reliance of coal power in Mongolia makes EV charging 2 to 3 times more polluting than more developed countries. This makes the emissions from E-bus nearly equivalent to those of their fossil-based counterpart.	Recommendation S6
Fast charging and e-bus charging infrastructures will require significant investments in the local grid and highly impacts the already highly loaded distribution	With loads of fast charging and e-bus infrastructure reaching up to 1 or 2 MW, will require significant investment and time in upgrading the local grid connections. Furthermore, with the city of Ulaanbaatar having on average most substations loaded above 60% will require additional investments in the distribution system.	Recommendation S6 and S8
The steps for realising EV charging infrastructures are not well known and sometimes delayed by lacking electricity infrastructures and bureaucracy.	Currently the synergy between various private and public stakeholders in the energy supply chain in developing EV infrastructure are not fully align. Furthermore, processes in realising grid connections for EV infrastructures are complex and long.	Recommendation S7 and S8

RECOMMENDATION S5: Promote Smart Charging technologies to Minimise EV Charging Impact During Peak Demand Hours

- 7.6 Common EV charging systems used for home charging typically have capacities up to 7 kW in a single-phase AC layout. In Mongolia, depending on the available connection, most home charging will vary between 2-7 kW and their individual installation will not require infrastructure upgrades at household level. At distribution network level, collective demand of EV home charging may also be possible without network upgrades when it does not coincide with existing peak household demand (e.g.,

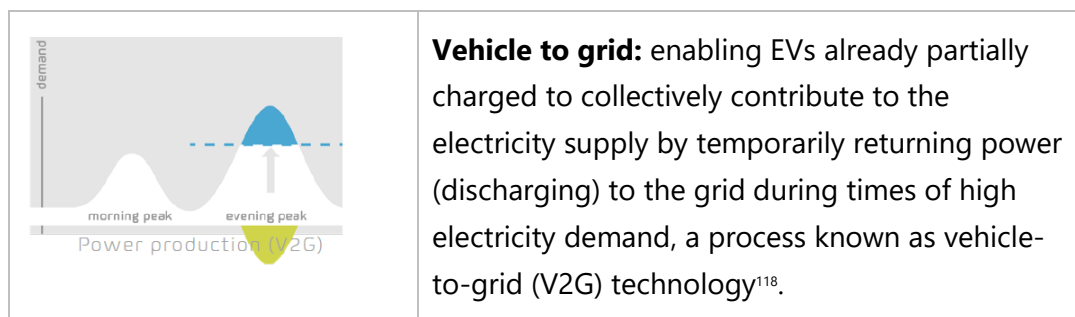
- overnight charging during off-peak periods). However, if there is a high level of EV uptake in a concentrated area, charging demand can coincide with peak household demand and might require some grid strengthening at low voltage levels, up to and inclusive of the supplying substations.
- 7.7 Incentivising smart charging solutions¹¹⁶ could shift this demand towards off-peak moments in the grid and therefore reduce the required upgrades. In more developed EV markets, the deployment of smart charging has shown to decrease collective peak demand EV's on the grid by 15%¹¹⁷.
- 7.8 Smart charging can be implemented through various strategies, each designed to optimize energy usage and grid stability. For Mongolia the most relevant strategies to avoid the impact of home and public charging are the valley filling and load shifting, as shown in Table 7-2. Additionally, the smart charging technology framework can also be used to discharge energy from the vehicle battery to the grid at peak demand times. Given Mongolia's energy peak challenge, this is also clearly aligned with energy policy related to EVs.

Table 7-2: Smart charging objectives for Mongolia

 Valley filling	Valley Filling: This involves incentivising the charging of vehicles during times of low electricity demand, effectively 'filling' the valleys in the demand curve.
 Load shifting	Load Shifting: Involves actively reducing charging rates during peak demand periods to prevent grid overload. Conversely, EVs charge more quickly when demand is lower.

¹¹⁶ Consist of solutions influencing one (or more) charging points with (collective) command signals to obtain an instantaneous demand shift or reduction.

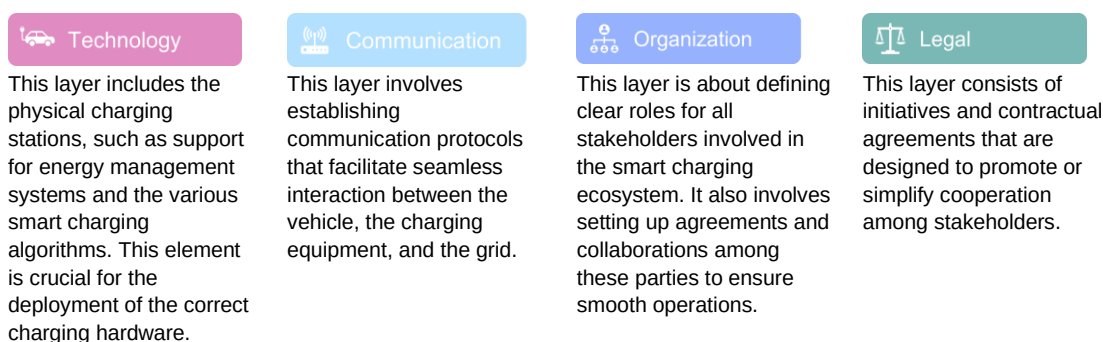
¹¹⁷ Siemes, M. (2024, May 2). *Utrechtse proef toont aan: slim laden op basis van flexibele nettarieven verlaagt de piekbelasting op het elektriciteitsnet*. ElaadNL. <https://elaad.nl/utrechtse-proef-toont-aan-slim-laden-op-basis-van-flexibele-nettarieven-verlaagt-de-piekbelasting-op-het-elektriciteitsnet/>



Smart charging implementation

- 7.9 While charging infrastructure is the most visible component of smart charging technologies, charger technology deployment needs to be enabled through three additional layers of, specifically communication, organisation and legal, as shown in Figure 7-2.

Figure 7-2: Smart charging implementation and governance



Technology layer

- 7.10 Table 7-3: Smart charging technology options for below outlines the recommended smart charging technologies for Mongolia in the short and medium term across the different vehicle charging types, specifically home charging (longer term, as EV penetration and grid demand increases) and EV fast charging (a more established technology and short-term need in Mongolia).

¹¹⁸ Vehicle to grid charging strategy requires the presence of dedicated markets and compatible hardware in place in order to function.

Table 7-3: Smart charging technology options for Mongolia

Technology	Current status	Recommendation	Timeline
Home charging hardware including smart charging algorithms	Not common Not included in Mongolia's EV standard or incentives.	Introduce financial incentives or standards ¹¹⁹ to promote or enforce the installation of home smart chargers.	Short term: no actions Long term: Enforce through standards
Public charging points including smart charging algorithms ¹²⁰	Readily available Not included in Mongolia's EV standard or incentives.	Introduce financial incentives to enforce the installation of public smart chargers.	Short term: Make standard for public tenders and concessions. Long term: Enforce through standards
Support for vehicle to grid EV's and bi-directional charging hardware	Still in development	Enable the support of bi-directional charging points and making the grid suitable for vehicle to grid services.	Short term: No actions Long term: Financial incentives Incorporate bi-directional capabilities into the grid code

Communication layer

- 7.11 Standards and protocols are the foundational languages enabling seamless communication between devices. Open standards, which are accessible to all industry players, are preferable. Europe leads in developing these open communication standards, with the global community gradually adopting them. In Mongolia, where the EV infrastructure is still developing, the visibility of these standards is still minimal.
- 7.12 At this early stage, basic open standards are recommended for implementation of charger-centric and vehicle-centric standards in Mongolia.

Charger centric

This is where the grid operator gives a signal that runs via the back-office system to the Smart Charging station. The

¹¹⁹ As of June 2022 UK's government introduced a smart charging as standard regulation for home chargers. Seymour, T. (2023). *Smart charging for EVs: What is it and how does it work?* <https://www.smarthomecharge.co.uk/features/smart-charging-for-electric-vehicles/>

- **OSCP (Open Smart Charging Protocol):** is an open communication protocol between the charging point management system and the grid operator (regional grid or national grid operator). The protocol can allow UBEDN to communicate a 24-hour prediction of the local available grid capacity (allocated to EV) to a CPO in certain area. The CPO will then fit the charging profiles of the electrical vehicles within the boundaries of the available capacity. This way UBEDN can protect fragile parts (or grid areas still in development) of the grid.
- **Open ADR (Open Automated Demand Response):** is an open standard for exchanging 'Demand Response' signals, or signals related to price or charge control between DSO's, energy suppliers and CPO's). This will allow DSO's and energy suppliers to implement a demand response market system influenced by the price of energy or real-time congestion of the grid. For Mongolia this relevant in protecting highly loaded (or unpredictable) areas in the grid, or to implement a market incentive to charge outside energy import periods.

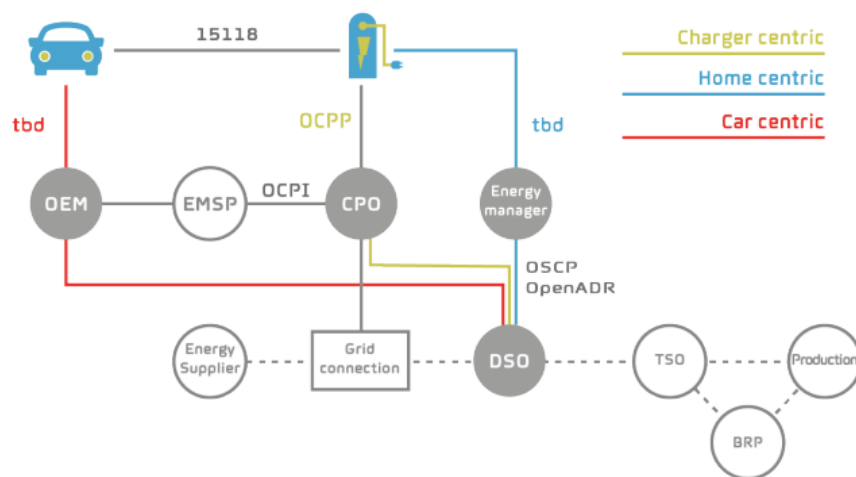
7.13 Supporting OSCP and Open ADR at (semi) public charging points is essential for enabling collective valley filling and peak shifting smart charging. Introduction of this into Mongolia's EV ecosystem requires effort both from private and public stakeholders. Private CPO's will need to support the protocol at their charging points, with MRTD regulating and incentivising their use through policies and NDC and UBEDN integrating the protocol in their grid monitoring and control systems.

Vehicle centric

7.14 Vehicle centric communications protocols are where the vehicle receives real-time information or generates a Smart Charging control signal which could be provided by a party needing flexibility - the regional grid operator, the national grid, or another party - or through an intermediary, an "aggregator". The key communication protocol here is:

- **OCPI (Open Charge Point Interface):** between a CPO and a Third Party, usually being an energy supplier or charging point aggregator. This makes possible to implement a commercialized demand response service at multiple charging points.

7.15 In the longer term, supporting OCPI at (semi) public charging points will be key for enabling vehicle to grid. Introduction in Mongolia's EV ecosystem requires effort from UBEDN, NDC, ERC and future charging point aggregators. ERC will need to set up a tariff or market system for supporting demand response. UBEDN and NDC will need to integrate these markets systems into their monitoring and control systems.



Organisational layer

Roles of EV stakeholders in the implementing smart charging in Mongolia

7.16 Table 7-4 and Table 7-5 describe the roles and interests of private and public stakeholders involved in the Smart Charging ecosystem, the roles and interests at play.

Table 7-4: Private stakeholders

	EV suppliers	Charge point operators	Charge point suppliers	Aggregators
Objectives	Sell EVs to Mongolians	Deliver charging service to EV users	Sell and install charging points to CPO's	Aggregate EV charging and offer vehicle to grid charging
Mongolian context	MSM (BYD), Leaf Centre (Nissan)	PetroVIS, E-mart	EV retailers, EPC contractors	Not active in Mongolia
Role in smart charging	Supply smart charging supported cars in Mongolia	Install smart charging supported charging points	Supply smart charging supported charging systems	Provide grid-based services for vehicle to grid.

Stakeholder activation	• EV standards • EV financial incentives	• Hardware and communication standard • Financial incentives (subsidies, energy tariffs, introducing new markets)	• Hardware and communication standard • Financial incentives (subsidies)	• Financial incentives (demand response markets, energy tariffs, grid services)

Table 7-5: Public stakeholders

	Grid provider and energy suppliers	Policy makers	Regulatory of the energy sector	Municipalities
Objectives	Maintain reliability of the energy system and lower system costs	Increase the use of EVs in Mongolia	Implement and reform grid tariffs	Deploy public charging points
Mongolian context	UBEDN, MOE and NDC	MRTD	ERC	MUB
Role in smart charging	Make communication pathways between grid and charging point available	Implement incentives or regulation to promote the use or deployment of smart charging points	Introduce tariffs to support smart charging, such as time of use or grid demand base tariff structures	Implement public charging points capable of supporting smart charging algorithms

	Grid provider and energy suppliers	Policy makers	Regulatory of the energy sector	Municipalities
Stakeholder activation	Support in setting up demand response and grid services markets	Support in setting up EV and charging subsidies, standards	Support in setting up time of use or grid demand-based tariff structures	-

Legal layer

- 7.17 The legal layer mostly consists of contracts and agreements that can enable stakeholder to collaborate on smart charging. As shown in Table 7-6 below, in the case of Mongolia, the most relevant legal aspects relate to the energy tariff regime, providing incentives to CPOs to align energy use with off-peak times.

Table 7-6: Legal and regulatory recommendations for smart charging

Opportunities	Description	Involved stakeholders
Flexible rate contracts (ToU)	With these contracts, electricity rates vary based on the time of day or season, featuring lower rates during off-peak hours and higher rates during peak hours. This pricing model encourages Charge Point Operators (CPOs) and businesses to shift their energy consumption away from peak times, promoting a more balanced energy usage across the grid. (Note: These are contemplated in the EV Charging Tariff section).	CPO's and NDC Households and NDC

Bandwidth-based contracts	These contracts provide a set bandwidth of electrical capacity that can be used flexibly. Users pay for a certain bandwidth of power availability rather than a fixed rate, which can lead to cost savings and incentivize smarter energy use.	CPO's and UBEDN

RECOMMENDATION S6: Promote and Incentivise Microgrid Solutions with RES to Reduce Grid Impacts and Carbon Intensity of EV Charging

Context

- 7.18 Mongolia's aging and highly loaded electrical infrastructure is causing grid congestion in most substations in Ulaanbaatar. The country's heavy reliance on coal power for its electricity generation makes EV charging stations in Mongolia significantly more polluting, with passenger cars emitting only 25% less GHG than combustion engine vehicles, while e-buses have comparable (even greater) emissions.
- 7.19 With limited decarbonisation of the energy grid anticipated in coming years, and no end-user market for RES, for EVs to support decarbonisation in Mongolia it will be necessary to prioritize deployment of microgrid solutions that include localized RES generation and Battery Energy Storage Systems (BESS) supported by energy management systems. This will be in particular helpful for BEBs, which currently do not mitigate GHG emissions when charged through grid energy.
- 7.20 Microgrid infrastructure will also help to mitigate the costs and delivery challenges of grid connections for larger charging stations. The installation of fast charging stations and e-bus charging infrastructure also often leads to higher demand peaks than the existing load can handle, putting strain on the wider distribution network.
- 7.21 For example, the E-Mobility Assessment analysed likely infrastructure costs to provide E-bus charging to the bus depots considered for electrification (see Figure C 1) by MUB. Considering demand¹²¹ and available capacity¹²² of the 14 substations from which they are supplied, the short-term and longer-term investment costs are shown in Table 7-7 with full details included in Appendix C.

¹²¹ Based on a estimated requirement of 1 MW charging capacity per location.

¹²² Based on data obtained by NDC and UB Masterplan 2040.

Table 7-7: Short- and long-term infrastructure investment for MUB e-bus proposal

Short term investments (2024 – 2030)	Long term investments (2030-2050)
21.6 million USD	32.9 million USD

- 7.22 Additionally, upgrading electrical substations is also a long process which can take 4-8 years. In the short term this might delay the roll-out of e-busses in Ulaanbaatar. An alternative for the short-term grid investments is to implement micro grid solutions for high impact EV charging stations. A micro grid charging station offers a solution to better integrate localized RES generation¹²³ and BESS¹²⁴ to manage the adverse effects of EV charging on the grid.

Examples of possible microgrid EV charging in Ulaanbaatar

- 7.23 Implementing microgrid charging solutions depends on the type of charging modality, space availability, availability of RE sources¹²⁵, grid connection availability, and number of chargers at the charging location. The following describes this for the most relevant EV modalities for Mongolia including an example of how implementation could look like in Mongolia versus conventional charging stations. The below case studies show purposeful, worked examples and comparative costs for microgrid EV charging in Ulaanbaatar.

Workplace, shopping centres or recreational areas

- 7.24 As the adoption of EVs grows, these will typically be sites featuring 10-30 AC Level 2 charging points, potentially adding 210-330 kW of peak demand, which may surpass many buildings' grid capacity, using solar carports or rooftop PV (see Table 7-8 and Table 7-9).

¹²³ Most common localized RES generation are rooftop solar PV and solar PV-carport installations. Additionally in some cases an EV charging can connect to nearby solar PV parks or wind turbines (such as next to highways).

¹²⁴ BESS systems can be implemented in the form of one or two charging points having a small integrated battery system or as a larger standalone containerized solution that serves several charging points.

¹²⁵ Ulaanbaatar faces the challenge of having lower PV radiation potential than rural areas due to the presence of heavy pollution. In some cases, systems are to be oversized to obtain the desired yield.

Table 7-8: Example of destination charging infrastructure



Table 7-9: Typical destination charging characteristics

Use pattern	Local RES generation	Local Storage	Local control
Demand mostly occurs during business hours, peaking typically around the start of day.	Solar PV carports (covering parking spaces)	Charger integrated BESS systems	Benefit from local RES by concentrating EV charging in the middle of the day.
210 – 330 kW demand	Rooftop solar PV (building)	Small scale containerized BESS only if grid capacity is limited.	Sites with limiting grid connection, should implement smart charging or a small BESS for peak-shaving.
	Ca. 50 – 200 kWp	Ca. 50 kWh – 500 kWh	

Case study – MRTD Offices

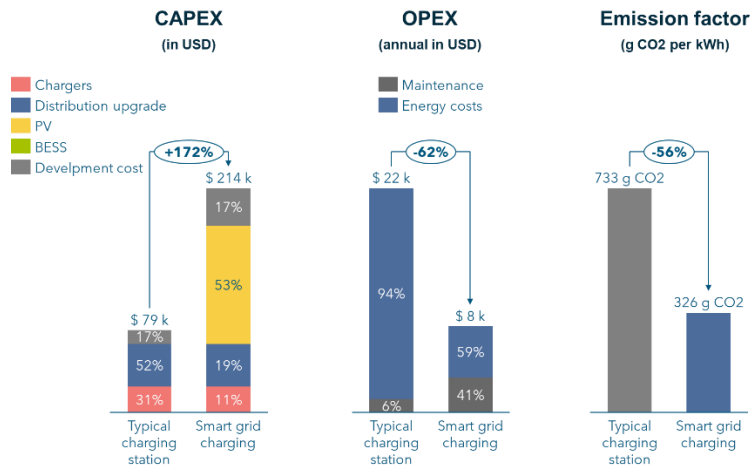
- 7.25 In Ulaanbaatar, the Ministry of Road and Transport Development (MRTD) offices have already implemented solar carports over several EV charging spots, with potential for more across the other 60-70 parking spaces. The current setup spans approximately 200 m² of solar panels as shown in Figure 7-3 below. Analysis of the relative capital and operating costs is provided in Figure 7-4.

Figure 7-3: Case study - MRTD Offices



CAPEX	OPEX	Emission factor	Lifetime financial impact
The initial investments for microgrid charging are around USD 214k , this is more than 2 times higher than conventional charging stations ¹²⁶	Due to a portion electricity being produced by local RES generation ¹²⁷ , the OPEX reduces by 62% .	Emissions decreases by more than half aligning the EV emissions with neighbouring countries like the Netherlands	Considering a lifetime of 25 years. This results in 0,02 USD per kWh less than a traditional station.

Figure 7-4: Capital and operating cost for destination charging using microgrid vs traditional charging (includes energy)¹²⁸



¹²⁶ Assuming local distribution upgrades are needed

¹²⁷ Based on PVGIS-ERA5 solar radiation data for Ulaanbaatar

¹²⁸ BESS capacity is excluded from this case study due to the use pattern for workplace chargers already coinciding with the local RES generation (i.e. daytime).

Fast charging stations (opportunity chargers)

7.26 Fast charging stations cater to EV charging along highways, recreational areas, or opportunity charging of e-bus fleet. They typically include two to six DC fast chargers of 50-250 kW resulting in stations needing charging capacities up to 1500 kW. In the initial phases, 1 or 2 fast charging points of 50 kW can be supported by standard grid connections at petrol stations. As demand grows, stations with four to six fast charging points (rated at 250 kW per charger), will face challenges in locations with limited grid capacity. Figure 7-5 and Table 7-10 below show the characteristics and relative costs of microgrids for fast charging applications. Proposed examples for Ulaanbaatar are shown below for the Petrovis Peace Bridge Station in Figure 7-6 and Figure 7-7, and the Petrol station TES in Figure 7-8 and Figure 7-9.

Figure 7-5: Fast charging stations



Table 7-10: Typical characteristics of microgrids for fast EV charging

Use pattern	Local RES generation	Local Storage	Local control

Fast charging stations experience peak activity during midday and afternoon/early evening hours. <i>Up to 250 - 1500 kW peak demand</i>	Solar PV carports (covering parking spaces) Rooftop solar PV (building) Connect to nearby solar PV park or wind turbine <i>Ca. 50 – 200 kWp (larger if nearby PV park or wind turbine is available)</i>	Charger integrated BESS systems Medium scale containerized BESS <i>Ca. 500 kWh – 1000 kWh</i>	Use BESS to balance RES generation for usage around the afternoon / early evening hours. Sites with limiting grid connection, should implement BESS for peak-shaving by charging BESS between EV charging sessions.

Case Study: Petrovis Peace Bridge Station

7.27 Projected to have four fast charging points, this station has 250 m² of roofing space for solar panels and an additional 250 m² for a solar carport expansion, leading to an estimated 78 kWp installation. An 800 kWh containerized BESS solution is planned for peak-shaving.

CAPEX

The initial investments for microgrid charging are **USD 738k, this is 30% higher** than conventional charging stations¹²⁹

OPEX

Due to a portion electricity being produced by local RES generation¹²⁷, **the OPEX reduces by 21%.**

Emission factor

Emissions decreases by 32%, aligning the EV emissions with neighbouring countries like China

Lifetime financial impact

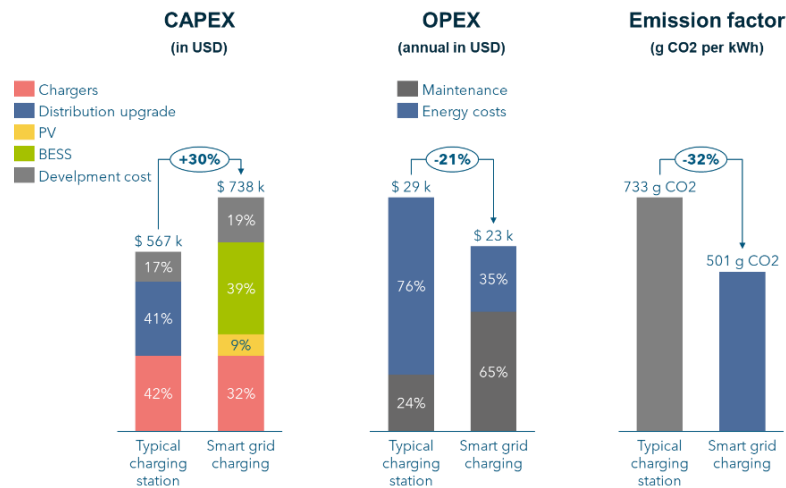
Considering a lifetime of 25 years. **This results in 0,03 USD per kWh more** than a traditional station.

¹²⁹ Assuming local distribution upgrades are needed

Figure 7-6: Case study - Petrol station Petrovis Peace Bridge



Figure 7-7: Comparative TCO for microgrid fast charging at Peace Bridge



Source: Study team modelling

Case Study – Petrol station TES

7.28 At this location, four fast charging station points are envisioned charging daily around 1000 kWh. There is 1000 m² of space for ground mounted solar PV system at the location, resulting in a 156 kWp installation, space for a 550-kWh containerized BESS solution.

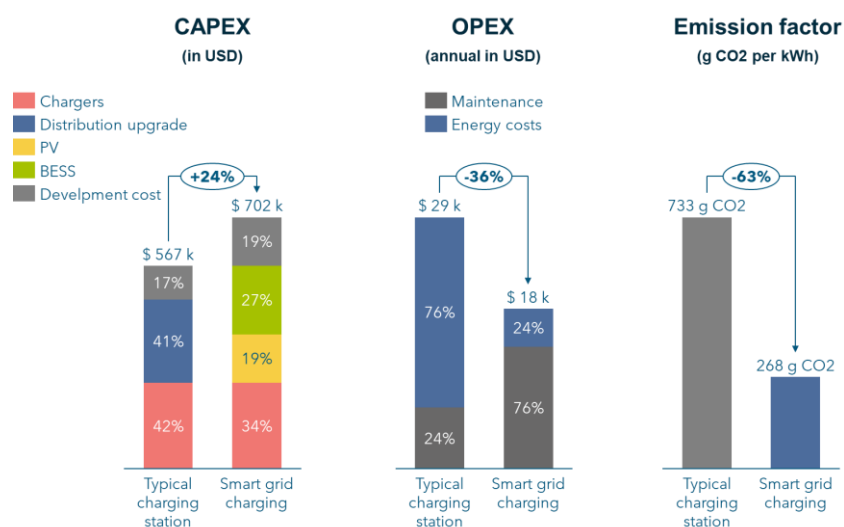
CAPEX	OPEX	Emission factor	Lifetime financial impact
The initial investments for microgrid charging are USD 702k, this is 24% higher than	Due to a portion electricity being produced by local RES generation ¹²⁷ , the OPEX reduces by 36%.	Emissions decreases by 63% , aligning the EV emissions with countries like the Netherlands	Considering a lifetime of 25 years. This results in 0,01 USD per kWh more than a traditional station.

conventional charging
stations¹³⁰

Figure 7-8: Petrol Station TES microgrid fast charging site



Figure 7-9: Relative costings for microgrid fast charging at 32 Petrol station TES



Source: Study team modelling

Bus and fleet depot

- 7.29 Bus or fleet depots serve the changing needs of heavy electric vehicles (such as E-buses or E-trucks). In Mongolia, E-buses play a significant role, especially in the early stages of EV adoption in Ulaanbaatar. Currently, depots only use several opportunity chargers at Depot 2 in Ulaanbaatar. While this setup is feasible for now, it won't suffice as the fleet grows. As the number of buses increases, depot chargers capable of

¹³⁰ Assuming local distribution upgrades are needed

simultaneously charging 10-30 buses will be necessary. These depot chargers typically include 10-30 slow charging points, along with several opportunity chargers rated at 125-250 kW. Looking ahead, we anticipate similar charging powers to be required for e-trucks as well and will be mostly charging during the night.

7.30 An example of microgrid applications for e-bus depots is shown in Figure 7-10. A worked example of Ulaanbaatar’s Bus Depot 2 (visited by the consultant team) is shown in Table 7-11, alongside spatial arrangement (Figure 7-11) and relative costings in Figure 7-12.

Figure 7-10: Renewable energy and microgrid e-bus charging solutions



Various suppliers (Siemens, Schneider Electric) offers an e-bus micro grid solution for charging depots. This includes RES.



To bridge the gap between solar generation (middyay) and night-time charging large-scale BESS are needed to shift this generation.

Table 7-11: Typical characteristics of e-bus charging microgrids with RES

Use pattern	Local RES generation	Local Storage	Local control

The high usage patterns of large-scale charging depots vary based on the supplying service schedules (bus/truck). However, in general a depot with depot chargers and will experience a steady peak load outside of service times (usually overnight during off-peak hours) and several isolated peaks during the midday (during shoulder times) due to the opportunity chargers. <i>Up to 250 - 1500 kW peak demand</i>	Solar PV carports (covering parking spaces) Rooftop solar PV (depot building) Connect to nearby solar PV park or wind turbine. <i>Ca. 500 – 1000 kWp (larger if nearby PV park or wind turbine is available)</i>	Large scale containerized BESS <i>Ca. 800 kWh – 2000 kWh</i>	Use BESS to balance RES generation towards evening hours. Sites with limiting grid connection, should implement BESS for peak-shaving by charging BESS during service schedules.

7.31 **Case study – Bus depot 2:** Bus depot 2 serves as an example for a depot in the centre of Ulaanbaatar midst of the EV transition. This depot can store 46 buses. Positive of such depots is the fact that they have roof space to accommodate solar PV both on the Bus depot self but also on service garages. Here we estimate 2x 4.500 m² of bus depot roof space and 1x 2000 m² of Maintenance shop. Furthermore, the bus depot has an available grid connection of 650 kVA, however this already mostly in use by the existing opportunity charges. There is sufficient space on-site for a BESS system.

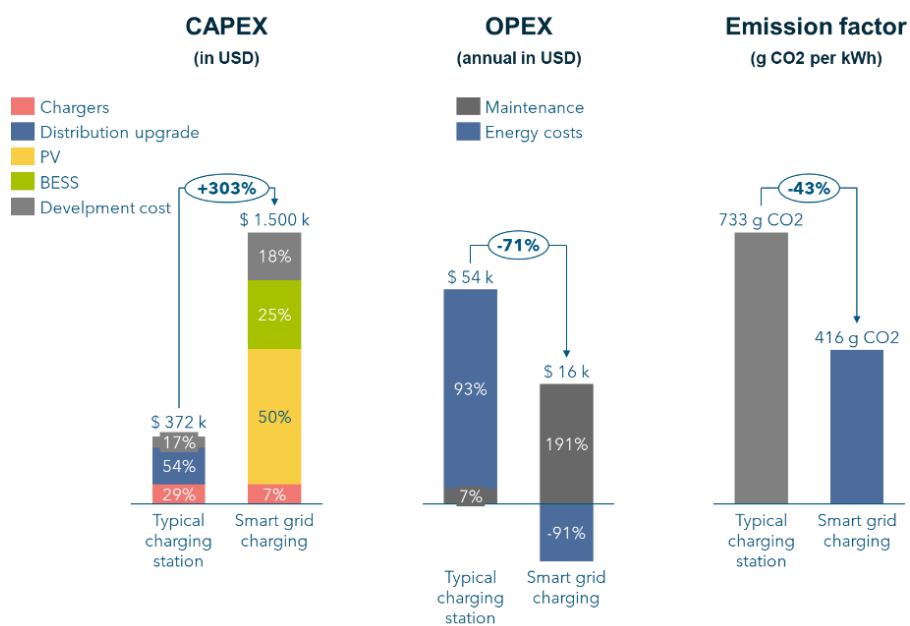
CAPEX	OPEX	Emission factor	Lifetime financial impact
The initial investments for microgrid charging are USD 1,5 – 2,1M, this is 3-4 times higher than conventional charging stations for bus depots ¹³¹	Due to a portion electricity being produced by local RES generation ¹²⁷ , the OPEX reduces by 49 – 71%.	Emissions decreases by 42% , aligning the EV emissions with neighbouring countries like China	Considering a lifetime of 25 years. This results in 0,02 - 0,03 USD per kWh more than a traditional station.

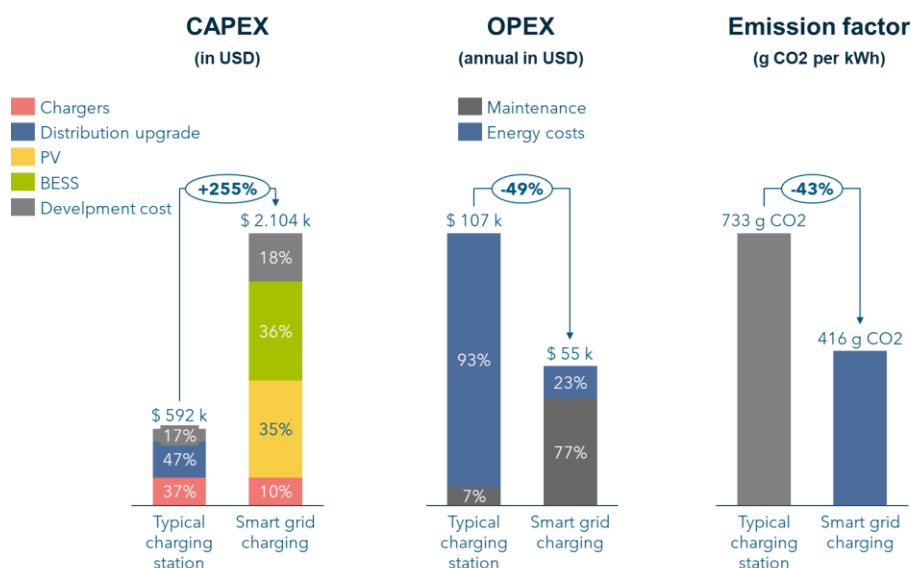
¹³¹ Assuming local distribution upgrades are needed

Figure 7-11: Spatial arrangement of microgrid for e-bus depot charging at Bus Depot 2



Figure 7-12: Comparative costs for microgrid e-bus charging at Bus Depot 2 (10 bus and 20 bus capacity respectively)





- 7.32 In order to prevent any delays in the deployment of e-buses, it is essential to consider an alternative to the short-term grid investments. In the early phase of implementing e-buses, 8 bus stations would require the installation of a smart grid. Assuming that these stations would supply 10 e-buses each, this would necessitate an investment of USD 12 million. This amount represents half of the cost of directly upgrading the grid and can be completed within a timeframe of 1-2 years. Additionally, these upgraded stations would result in lower emissions and operating expenses.

Figure 7-13: Smart grid examples



Shell Energy in Zaltbommel, The Netherlands: Due to the Dutch grid coping with grid congestion, Shell implemented a BESS integrated fast charging station at their Zaltbommel service station. The battery assist the charging station during peak demand, increasing the available charging speed on location from 100 kW to 300 kW.



WattHub, The Netherlands: Is an innovative charging hub for heavy e-mobility, integrating smart charging and smart grid techniques to balance the electricity use of nearby solar and wind generation.

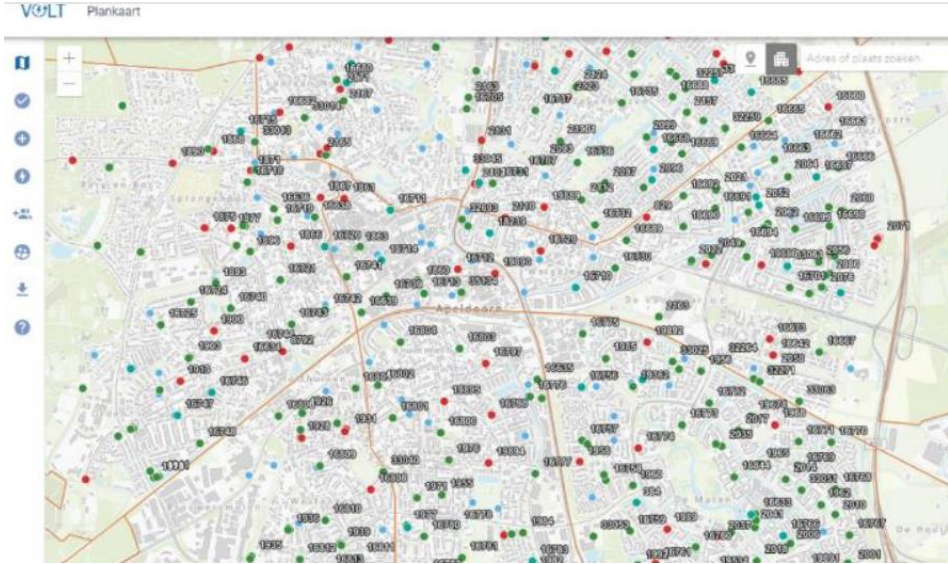
RECOMMENDATION S7: Strengthen EV Charger Planning and Implementation in Partnership with Private Sector Stakeholders

- 7.33 As outlined in the readiness section, a number of public sector and private sector public EV charging point initiatives exist, almost all in Ulaanbaatar. In order to meet the

future need for EV charging infrastructure, coordination will be necessary to ensure coverage meets demand, infrastructure is provided where grid capacity exists, and that the types of chargers minimise grid impact and meet user needs. Fundamentally, operation of public EV charging should be seen as a commercial activity in the long term (in the same way as ICE fuelling stations are privately provided). As such, while public sector support is needed to catalyse EV charger coverage, this support should seek to promote and shape a private sector ecosystem and EV charging market.

- 7.34 Our recommendations for a coordinated EV charger planning and deployment model are shown in Table 7-12.

Table 7-12: Recommendations for EV charger planning and deployment.

Defining locations	Develop a proactive EV plan map In the development stage, an EV Planning Map can be produced of a region where EV charging infrastructure is to be developed. This is a pre-made (usually dynamic) map which uses spatial, traffic and population data to identify potential sites which may be attractive and suitable for EV charging based on various data sources¹³². This will simplify procurement and allows both the municipality and CPOs to maintain an overview of the local public charging infrastructure, without having to search for a suitable charging location ad-hoc each time. An example of this from the Netherlands is shown below and in Appendix D. Figure: An example of an CPO mapping tool using RHDHV's VOLT tool¹³³ 

¹³² This includes considering forecasts indicating the number of needed charging stations in a neighbourhood, the distribution throughout the neighbourhood, and various local factors such as minimum sidewalk width, trees, street objects, and distance to power cables. These factors can be tailored to the local situation to create a suitable plan for each municipality. This also gives the option to present the map to residents or other stakeholders in a participation process and incorporate valuable local input, after which planned charging locations can potentially be changed.

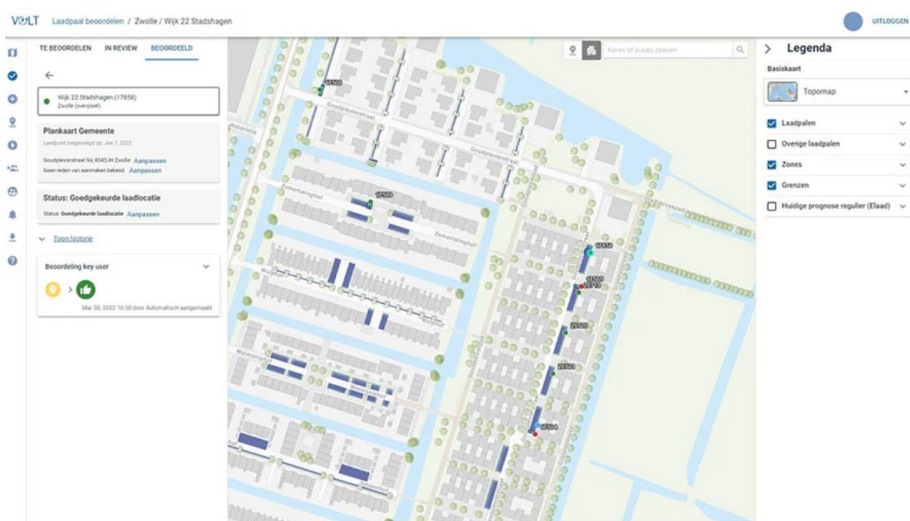
¹³³ Royal HaskoningDHV. (n.d.). *Plan and manage your EV public charging infrastructure*.

https://dl.dropboxusercontent.com/s/l2a6gdbve8hdpbw/VOLT%20Brochure%20-%20English_v1.1.pdf?dl=0

Create EV Charging Point request portal

A request portal will allow EV users to make requests for charging points at locations where these are in demand but not currently available. This is particularly important for Ulaanbaatar, where not all EV users (or aspiring EV users) have access to private parking, making semi-public charging points a key enabling factor. An example of this is the request portal in the UK provided by Shell Recharge (previously Ubitricity)¹³⁴ or Laadpaalnodig platform¹³⁵ in the Netherlands, which is a unified platform for the whole municipality.

Figure: EV Charging Point Request Mapping



Monitor the use of existing charging points

Task CPOs to monitor the charging activity of already deployed charging points and generate automatic requests for additional charging points in high traffic locations.

Procurement

Simplify the procurement process for the deployment of charging points

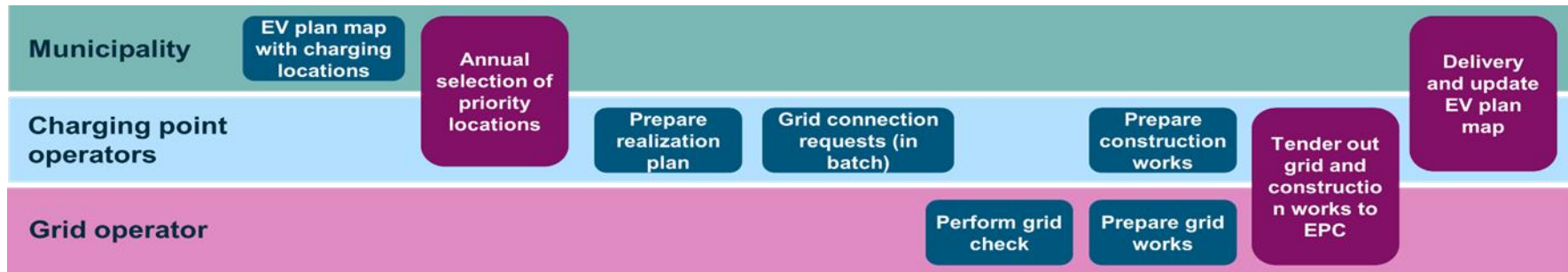
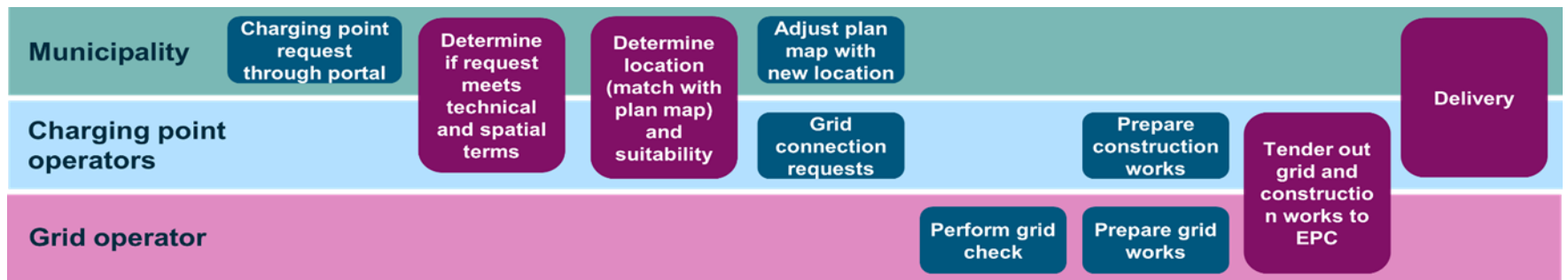
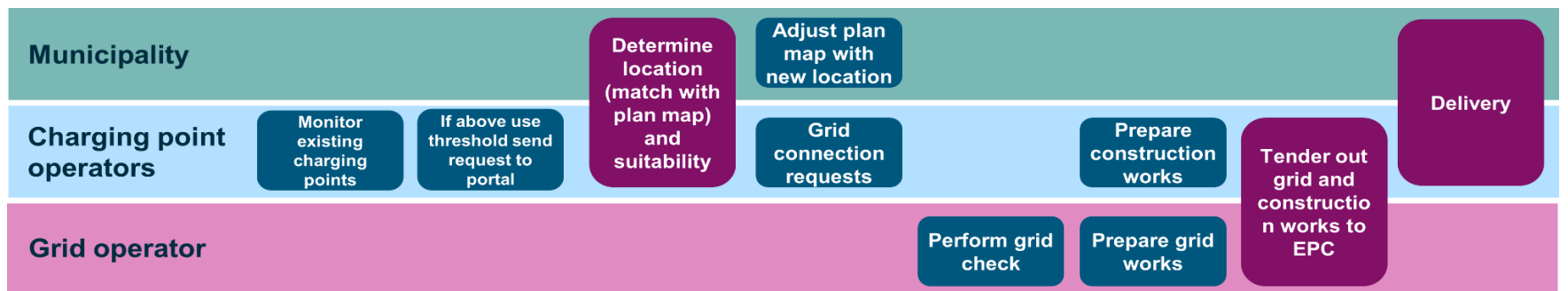
by going into long term collaboration agreement with the private sector. It is common in more developed EV countries (e.g., Netherlands, Germany etc.), for municipalities to tender out specific areas within cities for the placement of EV charging stations by means of defined term concession processes. Municipalities will proactively allocate charging points in the region and incorporate these aspects early in the processes, with responsibilities of CPOs to also identify need as capacity thresholds are met. This way the Municipality give the private market (CPO's) the responsibility to deploy and manage public charging points. This leaves room to the municipality to solely focus on the further definition of locations, acquire land and permitting. Due to the monopolistic situation of such concessions, municipalities will regulate the charging prices by setting a maximum price annually.

¹³⁴ Shell Recharge. (2024, April 23). *ubitricity Shell Recharge: On-street EV charging stations*. Ubitricity. <https://ubitricity.com/en/driver/>

¹³⁵ Laadpaal Nodig - Direct online een laadpaal aanvragen in uw gemeente. (n.d.). <https://www.laadpaalnodig.nl/>

Type of chargers	Short term: Any AC level 2 charger (incentivise smart charging through financial methods) Medium term: AC level 2 charger supporting OpenADR or OSCP as a standard. Long term: AC level 2 charger supporting vehicle to grid¹³⁶
Streamlining execution	Implement a streamlined execution process by performing steps simultaneously and facilitating collaboration between the key private and public stakeholders (Municipality, CPO, and grid operator). This includes establishing a defined process for the three approaches described in Figure 7-14, Figure 7-15, and Figure 7-16. Furthermore, for the various actions that require close collaboration between the municipality, CPO, and grid operator (UBEDN), it will be important to assign a dedicated point of contact between the stakeholders. Further efficiency can be gained by involving the CPO in the grid checks and works preparation process, allowing CPO engineers to work directly with the grid provider on executing these time-consuming tasks. This collaboration saves time for the grid provider as they only need to review and maintain quality.

¹³⁶ Subject to technological developments in vehicle to grid technology

Figure 7-14 Streamlined public/private EV charging point realisation process using **proactive EV plan maps**Figure 7-15 Streamlined public/private EV charging point realisation process using **charging point request portals**Figure 7-16 Streamlined public/private EV charging point realisation process by **monitoring the usage of charging points**

RECOMMENDATION S8: Establish Coordination Mechanisms Between Grid Actors and EV Charging Point Operators

7.35 For EV grid integration, it is key to integrate the anticipated EV demand into the process of Mongolia’s energy planning. This involves identifying potential locations for new high impact charging modalities such as fast charging stations and E-bus depots. Furthermore, Mongolia currently lacks a central entity to unite private and public sectors for integrating EVs into the national energy system.

Figure 7-17: Grid capacity mapping examples; (left) Southern California Edison Charge Ready Program, (right) Grid Capacity map Netherlands

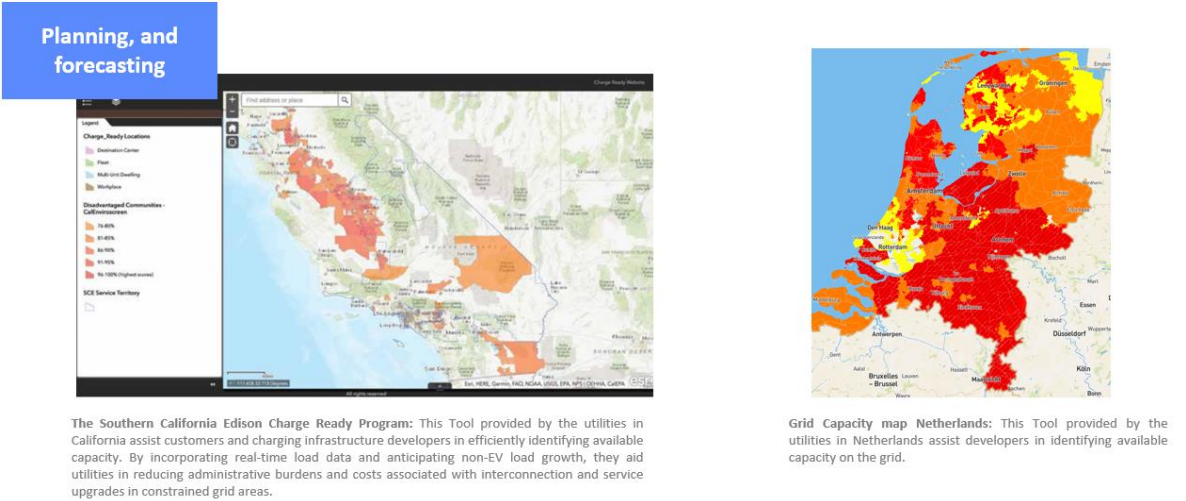


Table 7-13: Opportunities for EV grid integration in Mongolia.

Opportunities	Description	Example

Proactive grid-based EV roll-out	E-buses offer more predictability in terms of planning, as their energy infrastructure can be incorporated into the tender process beforehand. By matching charging locations with available grid capacity, smart charging needs can be identified early on and factored into the financials of the concession. This benefits both the grid provider, who can prioritize locations with limited capacity in their investment plans, and the concession participant, who gains confidence in the rollout process and reduces the risk of delays. To ensure a smooth transition to e-buses, it is recommended to align depot strategies with grid investments. A phased approach focusing on bus depots with existing capacity for EVs is advised. Our analysis highlights Dornod-2, Dari-Ekh, Tyelyeviz, and Ömnöd substations as ideal candidates for early adoption of e-buses, due to their low loading levels. Customising e-bus schedules to match the supply from these substations is also a viable option.	An example of a bus concession where stakeholder involvement is currently excellent is the city of Utrecht, Netherlands. The Municipality as the concession giver is responsible for installing the charging infrastructure. This charging infrastructure is then rented by the concession holder. By choosing this approach, it is possible to sit down at an early stage with the municipality, and grid provider to work out the plans. This includes having discussions the placement within the grid and aligning the timeline with existing grid investments. Where in some cases alternatives can be looked at for feasibility, costs, and lead time. Because all parties are already sitting down at this stage, there is enough time to make strategic choices and select the optimal alternative.

Reactive grid-based EV roll-out	UBEDN has the opportunity to implement a grid capacity map. This map would delineate the service areas covered by each substation in Ulaanbaatar, along with their available capacities. By doing so, CPOs and other entities involved in EV deployment can easily identify areas with adequate capacity. This facilitates a more efficient rollout process that aligns with UBEDN's capacity without causing additional conflicts with their own grid investment plans. Alternatively, considering the sensitivity of energy data for UBEDN, a map can be generated using limited estimations (grading of available capacities). Other options are to limit the access to the capacity map to only the application process for a grid connection. Additionally, it supports UBEDN in alleviating the administrative and financial burdens associated with interconnections and service enhancements in grid-constrained regions. Furthermore, in the case that local distribution upgrade is needed, it is also advisable to streamline the process by providing transparent information regarding infrastructure investments to aid CPOs in their long-term roll-out strategy.	A perfect example is the Southern California Edison Charge Ready Program¹³⁷ and the grid capacity map¹³⁸ in the Netherlands. Both tools are provided and updated by the utilities to assist customers and CPO's in efficiently identifying locations with capacity available on the grid.

¹³⁷ Charge ready. (n.d.). SCE. <https://www.sce.com/evbusiness/chargeready>

¹³⁸ Capaciteitskaart invoeding elektriciteitsnet. (n.d.). <https://capaciteitskaart.netbeheernederland.nl/>

Inclusive stakeholder sector engagement	Introduce a coordination taskforce to bring together key public and private stakeholders like EV suppliers, CPO's, the Energy providers (NDC), and grid providers (UBEDN, MOE) for collaborative efforts in the planning and deployment of Mongolia's EV charging infrastructure. This organisation can also aid in developing EV regulations and standards tailored to the Mongolian context.	An example is, the Electric Vehicle Association of the Philippines (eVAP)¹³⁹ also work in the Philippines on actively supporting EV adoption in the infrastructure. A Mongolian equivalent to eVAP would be a significant step towards a cohesive and sustainable EV ecosystem, streamlining adoption and showcasing Mongolia's commitment to a greener future.

RECOMMENDATION S9: Implement EV Charging Tariff

- 7.36 Like the Time of Use electricity tariffs currently used in Mongolia, EV charging tariffs serve a dual purpose to improve peak load management while proving lower cost energy to consumers at times of greater supply. The imperative for such tariffs is particularly important considering that private EV energy demand (using home charging) typically coincides with early evening energy demand peaks, making it particularly problematic for the energy grid.
- 7.37 Responding to this, EV tariff structures have been widely implemented in both developed and developing economies with higher EV penetration, including Canada, USA, UK and India. In addition to promoting off-peak charging, countries like USA have also implemented seasonal EV tariffs, with different rates for summer and winter seasons.

Case Study 1: EV tariff landscape for EV charging in India

- 7.38 Most Indian states have dedicated EV tariffs to promote EV adoption and support charging ecosystem development. EV tariffs typically optimise demand charges and reducing energy usage charges, including incorporation of a Time-of-Use (ToU) tariff. The key incentives and structures include:
- **Exemption or relaxation of demand/capacity charges** with more than 15+ states¹⁴⁰ having exempted demand charges in their EV tariffs and another 10

¹³⁹ Electric Vehicle Association of the Philippines. (n.d.). evap.com.ph. <https://www.evap.com.ph/>

¹⁴⁰ Some key states include Punjab, Delhi, Andhra Pradesh, Madhya Pradesh, Chhattisgarh, and Uttar Pradesh.

states¹⁴¹ + lowering demand charges (by between 10 to 90%), which is a particular benefit to CPOs to lower their fixed costs and thus promote their commercial feasibility.

- **EV Time-of-Use (ToU) Tariff:** Four states¹⁴² have introduced ToU tariffs to influence charging behaviour to encourage off-peak charging (i.e. overnight charging).

Case Study 2: Ultra Low Overnight Tariff in Ontario, Canada

- 7.39 The Ontario Electricity Board (OEB) has mandated energy suppliers to offer an 'Ultra Low Overnight Tariff' as of 2023, with the explicit aim of supporting the states target of 100% EV sales by 2035. The new ultra-low overnight rate sets overnight charging rates at 2.4 cents (CAD, US\$0.017) per kilowatt-hour (kWh), 67% lower than the standard time-of-use tariff, in exchange for which the peak rate is increased by 50% from US\$0.13 to US\$0.20.
- 7.40 The tariff responds to shifting demand to excess power during overnight periods, projected to reduce generation costs to the system by an estimated CA\$5.7m per year (US\$4.1m) subject to sufficient uptake¹⁴³.

Case Study 3: EV tariff landscape for EV charging in California

- 7.41 California has made significant progress in EV adoption as part of the USA's incentive-based EV transition. Several energy utilities have implemented EV charging tariffs to support EV uptake and manage grid impact. These include Pacific Gas and Electric (PG&E), San Diego Gas and Electric (SDG&E), and Southern California Edison (SCE) which have adopted different rate structures to support this initiative¹⁴⁴.
- 7.42 The EV tariffs are defined for both winter and summer season in Table 7-14 and Table 7-15, with demand charges below. The peak to off-peak rates for EV charging varies across summer and winter seasons. For winter season, this is 1.1 to 2.5X of off-peak tariff whereas for summer season it is 1.2 to 3.8X across different utilities (considering that energy demand peaks in California are in the hot summer months).

¹⁴¹ Some key states include Gujarat, Maharashtra, Karnataka, Tamil Nadu, and Telangana

¹⁴² Delhi, Maharashtra, Uttar Pradesh, and Telangana are some states offering ToU tariffs

¹⁴³ Ontario Newsroom. (n.d.). <https://news.ontario.ca/en/release/1002916/ontario-launches-new-ultra-low-overnight-electricity-price-plan>

¹⁴⁴ FORUM OF REGULATORS & MP Ensystems Advisory Private Limited. (2017). *Study on impact of electric vehicles on the grid* [Report]. <https://forumofregulators.gov.in/Data/study/EV.pdf>

Table 7-14: PG&E Tariff Structure for EV Charging

Plan	Season	Peak Rate (USD/kWh)	Part-Peak Rate (USD/kWh)	Off-Peak Rate (USD/kWh)
EV-A (Single Meter)	Summer	0.45	0.25	0.12
EV-A (Single Meter)	Winter	0.32	0.20	0.13
EV-B (Dual Meter)	Summer	0.45	0.25	0.12
EV-B (Dual Meter)	Winter	0.31	0.19	0.12

Table 7-15: SCE Tariff Structure for EV Charging

Plan	Season	Peak Rate (\$/kWh)	Off-Peak Rate (\$/kWh)
Separate EV Meter	Summer	0.16	0.09
Separate EV Meter	Winter	0.16	0.09

7.43 Demand charges impacts comprise:

- PG&E eliminated demand charges, also introduced a subscription model (USD 184 per 50 kW for large consumers, USD 25 per 10 kW for small consumers)
- SCE waived off demand charges from 2019 to 2023.

Evidence of behavioural shifts in EV charging behaviour from Canada

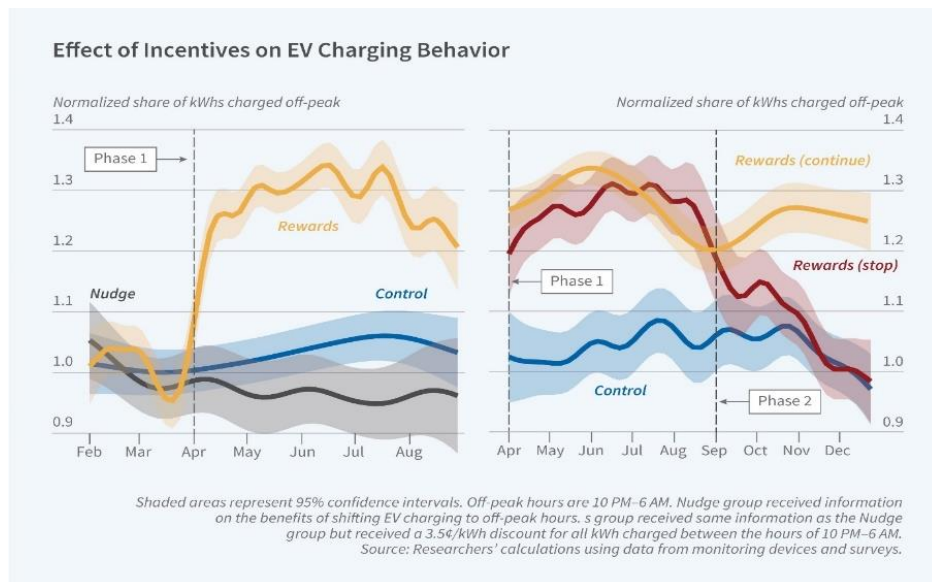
7.44 ENMAX Power, a municipally owned utility in Alberta, Canada, conducted a controlled cohort study to understand users' willingness to shift within-day EV charging based on financial incentives¹⁴⁵ and 'nudges' of information on societal benefits of off-peak charging. This found that a discount of 3.5 cents (US\$0.03) per kWh (approximately 23%) for overnight charging (10 PM to 6 AM) resulted in a 30% increase in overnight charging use among the incentivised group, and that behaviours reverted back to previous patterns where financial incentives stopped. Use of social nudges had no significant impact on behaviour either during after receiving the messages, while there was no change in the control group.

7.45 The changed behaviours are illustrated in Figure 7-18 below. The study supports the concept of financial incentives to shifting charging patterns, although their specific

¹⁴⁵ Bailey, M. R., Brown, D. P., Shaffer, B. C., & Wolak, F. A. (2023). *SHOW ME THE MONEY! INCENTIVES AND NUDGES TO SHIFT ELECTRIC VEHICLE CHARGE TIMING*. https://www.nber.org/system/files/working_papers/w31630/w31630.pdf

replicability will depend upon the various social, economic and cultural factors, together with the extent of the financial incentive.

Figure 7-18: Effect of incentives on EV charging behaviour¹⁴⁶



Context for an EV Tariff in Mongolia

7.46 As in most countries, Mongolia's energy tariff has two components:

- **Fixed charges:** Basic fee for residential and capacity charges for industrial category users. These fixed charges are billed irrespective of the consumption level and can have significant impact on the charging station operator's (CPOs) viability in case of low charging demand (e.g. low EV adoption scenario, lower charger utilisation, etc.)
- **Energy charges:** The energy charges are billed based on the consumption level. Typically, a user can be charged a) fixed rate per unit (single tariff)¹⁴⁷, b) slab-wise rates linked to consumption (telescopic tariff), c) Time of usage (peak, off-peak, shoulder). In the context of Mongolia, time of usage (ToU) tariffs are a well established practice aimed at promoting night time usage.

In Mongolia, electricity users are categorised into a) residential and b) industrial. Within these categories, EV users pay a tariff out of two options: a) single tariff and b) Time-of-Use (ToU) tariffs (i.e. 3-tariff meter: shoulder, peak, and off-peak) which are described in Table 7-16 and Table 7-17.

¹⁴⁶ Bailey, M. R., Brown, D. P., Shaffer, B. C., & Wolak, F. A. (2023). *SHOW ME THE MONEY! INCENTIVES AND NUDGES TO SHIFT ELECTRIC VEHICLE CHARGE TIMING*. https://www.nber.org/system/files/working_papers/w31630/w31630.pdf

¹⁴⁷ For EV charging, influencing charging pattern through single or telescopic tariffs is difficult due to the constant dependency on imports (except nights hours during summer season)

Table 7-16: Single tariff – Existing tariff

Category		Unit	Energy Charges	
Residential				
Fixed charge	Basic Fee	Per month	USD 0.570	MNT 2,000
Energy charge	Monthly above 150 kWh ¹⁴⁸	Per kWh	USD 0.045	MNT 155
Industrial- other industries, business entities and organisations				
Fixed charge	Capacity charges	Per kW/ month	USD 2.600	MNT 9,000
Energy charge	Other industries, business entities and organisations	Per kWh	USD 0.048	MNT 165

Table 7-17: ToU tariff – Existing Tariff

Category	Fixed charges	Unit	Energy Charges	
Residential				
Fixed charge	Basic Fee	Per month	USD 0.570	MNT 2,000
Energy charge	Shoulder (6 am to 9 pm)	Per kWh	USD 0.040	MNT 140
	Off-peak (9 pm to 6 am)	Per kWh	USD 0.032	MNT 110
	Peak (not applicable)	Per kWh	NA	NA
Industrial- other industries, business entities and organisations				
Fixed charge	Capacity charges	Per kW/ month	USD 2.600	MNT 9,000
Energy charge	Shoulder (6 am to 5 pm)	Per kWh	USD 0.049	MNT 170
	Off-peak (10 pm to 6 am)	Per kWh	USD 0.029	MNT 100
	Peak (5 pm to 10 pm)	Per kWh	USD 0.086	MNT 300

7.47 In Mongolia's current energy sector context, the shifting of additional EV energy demand to off peak times will be critical to enabling and accommodating EV uptake in the short, medium and long term. There is a strong culture of TOU tariffs for residential energy use both among users and energy sector regulators and other actors, and the

¹⁴⁸ For EV charging, monthly consumption is expected to be more than 150 kWh. Therefore, higher tariff will be applicable.

development of an EV-focused TOU tariff at this early stage of EV deployment has the potential to promote and reinforce charging behaviours among current and future EV customers' charging which will ease the long-term EV transition.

7.48 The EV tariff rationalisation methodology stems from the perspectives of three stakeholders: users, utility, and the government.

- **Users:** EV demand will occur primarily at home/offices, public charging points and dedicated charging locations (e.g. bus depots), considered in energy terms as either residential (home) or industrial (all other) users. The objective for users is to: a) promote night charging, and b) improve the economics of EV charging points (public charging stations) or EV operation (home/captive chargers). The proposed EV tariff will be applicable to all types of users.
- **Utility:** As explained elsewhere, new EV load presents a demand challenge for the system, and has economic implications (energy as an economic deficit/revenue stream plus grid investment costs). The proposed EV tariff structure should aim to support the energy system to manage both of these factors in the most cost efficient way possible, principally through peak shaving. For example, due to supply-demand mismatches, Mongolia often exports excess power during summertime night hours back to Russia at one-eighth of the import price¹⁴⁹, for which EV demand could provide an alternative market.
- **Government** - The dedicated EV tariff will facilitate options for government to provide subsidy/relaxations to support EV adoption and growth, in turn supporting decarbonisation efforts.

EV Tariff Estimation Analysis

7.49 The analysis of EV tariff was conducted based on several factors: a) existing peak load demand curve for CES region during the winter and summer seasons (as of 2023), b) grid impact due to the introduction of EVs, and c) existing electricity tariff structures including telescopic¹⁵⁰, single tariff or 3-tariff meter structure (also referred as time of use). The hourly demand data for a day's load curve for both winter and summer was collected from NDC, including the sources of generation, to understand the existing load patterns and identify peak and non-peak periods. Based on EV projections, the estimated EV charging load was distributed across different locations and time slots

¹⁴⁹ As per consultation with NDC

¹⁵⁰ Under the telescopic tariff structure, the rate of electricity increases with the increase in consumption thereby charging the consumers non-uniformly.

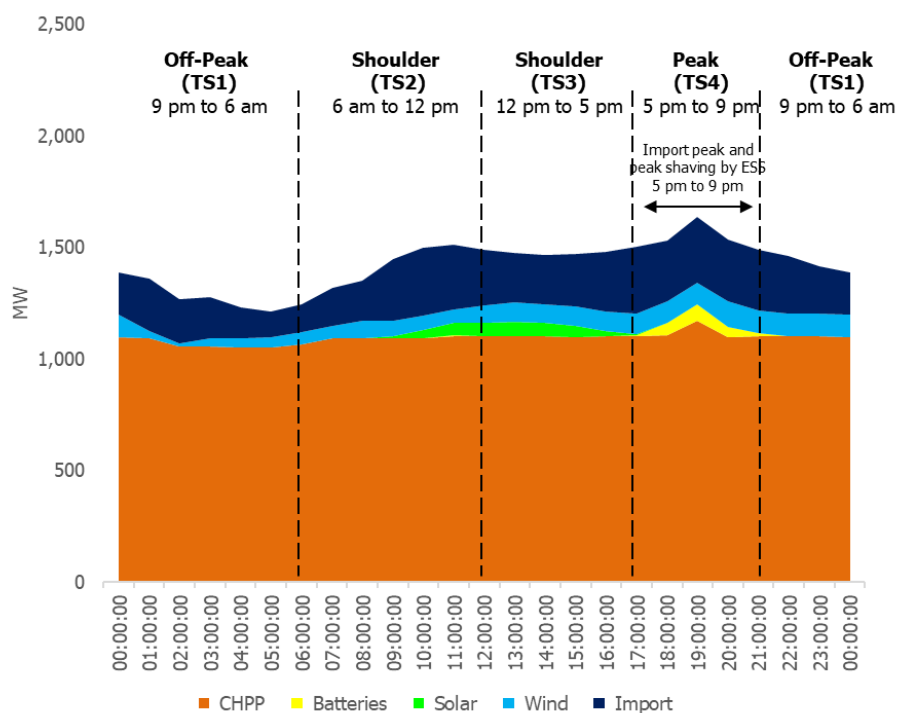
throughout the day. This analysis was further detailed to evaluate the impact of EV charging load on grid in terms of peak load demand.

Existing peak load assessment (for both winter and summer season)

7.50 As shown in Figure 7-19 the peak load for the CES region during the winter of 2023 was around 1,636 MW. The load curve has been segmented into four distinct time slots (TS1 to TS4). These timeslots are then correlated with the existing 3-tariff meter structure which includes off-peak, shoulder and peak periods. Based on the curve analysis, there are two peaks (TS2, TS4) and one off-peak period (TS1).

- Off-peak: 9:00 pm – 6:00 am (TS1)
- Shoulder: 6:00 am – 5:00 pm (TS2, TS3)
- Peak: 5:00 pm – 9:00 pm (TS4)

Figure 7-19: Average load curve in 2023 for CES region (winter) without EV load



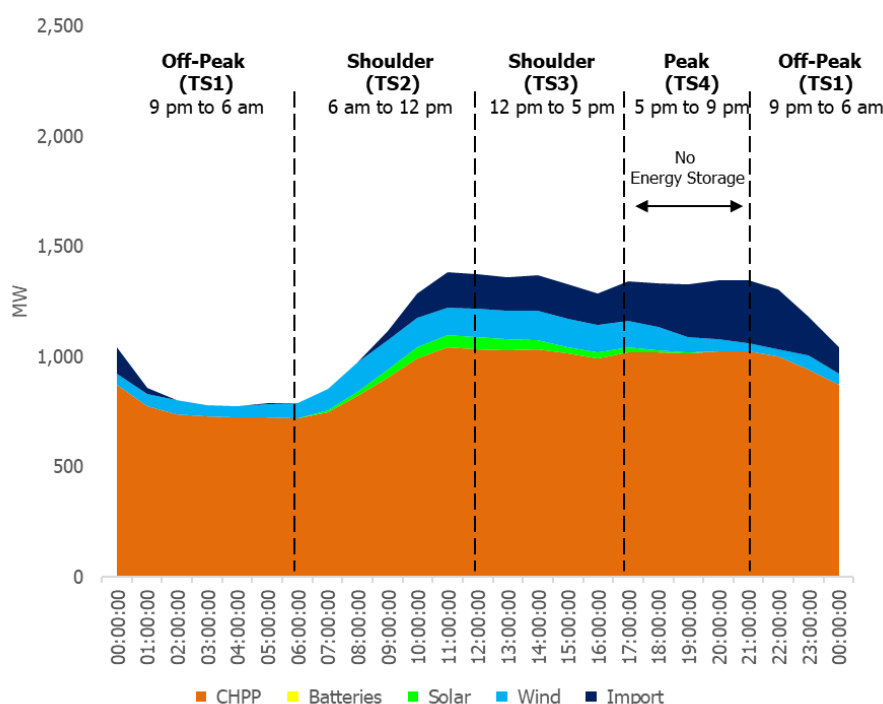
Source: National Dispatching Center (NDC), Mongolia

7.51 The primary source of power generation in Mongolia is predominantly CHPP power plants. Notably, during the winter season, the country exhibits significant dependence on electricity imports across all time slots. Currently, Russia serves as the primary supplier of electricity imports to Mongolia, with China poised to become an additional

supplier to meet the increasing demand. To address peak demand, particularly during evening hours (TS4), the country utilizes energy storage solutions (ESS)¹⁵¹.

- 7.52 As shown in Figure 7-20, the peak load (summer) of the CES region as of 2023 is around 1,039 MW. This represents a 36 percent decrease compared to the peak demand in winter. Notably, there is no dependency on imports during late night hours (after 1 am) to morning hours (till 8 am). Instead, Mongolia exports excess energy generated during this period to Russia, typically at a substantially lower price (reported as one eighth of the import price). This presents a favourable opportunity for utilities to promote EV charging during off-peak hours. Furthermore, unlike in the winter season, there is no necessity for batteries to manage peak loads.

Figure 7-20: Average load curve in 2023 for CES region (summer) without EV load



Source: National Dispatching Center (NDC), Mongolia

EV charging behaviour and grid impact

- 7.53 According to NDC data, the peak load (winter) for the CES region is projected to increase from 1,636 MW in 2023 to 3,076 MW by 2030, representing an almost 90 percent increase (CAGR of 9.4 percent). Similarly, the peak load (summer) is expected to rise from 1,039 MW in 2023 to 2,019 MW in 2030, an increase of nearly 95 percent (CAGR of 10.0 percent), though still 35 percent lower than the winter peak demand.

¹⁵¹ NDC. (2024). Response to study team's data request [Dataset].

This substantial growth in peak demand, with a CAGR exceeding 9 percent. This NDC demand forecast does not include EV charging load.

- 7.54 Based upon the Proactive scenario, demand for charging, including peak load in kW and unit consumption in kWh, is expected to follow the patterns shown in Table 7-18 and Table 7-19.

Table 7-18: EV charging demand by locations

Vehicle Segment	% of kWh by location		
	Public charging	Dedicated/ Captive charging	Home charging
Private cars (< 3 years)	10	0	90
Private cars (> 3 years)	10	0	90
Taxi - Mass market	50	50	0
Taxi - Premium market	50	50	0
Buses	0	100	0
Light urban freight	100	0	0

Table 7-19: Expected charging behaviour by timeslots (before EV tariffs)

Time Slots	Public charging	Dedicated/ Captive charging	Home charging
TS1 (9 pm to 6 am)	10%	25%	25%
TS2 (6 am to 12 noon)	35%	25%	13%
TS3 (12 noon to 5 pm)	35%	20%	12%
TS4 (5 pm to 9 pm)	20%	30%	50%

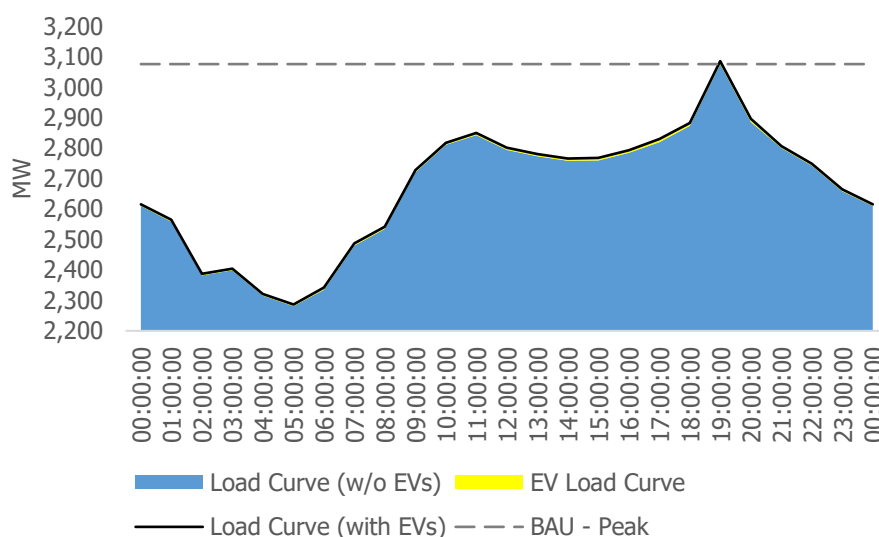
- 7.55 Based on these assumptions¹⁵², the charging demand was estimated across all timeslots and then hour-wise¹⁵³ for the year 2030. The peak load for 2030 in winter, both without

¹⁵² The assumptions presented are derived from past experiences across various projects and discussions with stakeholders in the charging business.

¹⁵³ To calculate hourly demand, the total EV charging demand of each timeslot is divided by total number of hours in each timeslot.

EV charging and including EV charging load (proactive case), is shown in Figure 7-21 below.

Figure 7-21: Estimated load curve in 2030 for CES region (winter) with and w/o EV load



- 7.56 The estimated increase in peak demand (5pm-9pm) due to EV charging load in the proactive vase is 15 MW (BAU: No intervention- 5 MW; BTB: Base case- 8 MW), which represents approximately 0.5% of peak-load during the winter season and could be further reduced using appropriate incentives within an EV tariff design (e.g., in Canada up to 30%). Nevertheless, depending on the concentration of EVs within the country, pressure may still be placed upon local distribution transformers (DTs).

Proposed EV Tariff Structure

- 7.57 To determine the most suitable tariff option for Mongolia, different tariff options/strategies are summarized in Table 7-20 below along with their pros and cons.

Table 7-20: EV tariff option considerations

EV tariff options	Load included	Key considerations
Single tariff (separate meter)	Only EV load	Installation of separate meter required for EV charging User and utility both can monitor EV consumption No incentive for night charging and high dependency on import during day-time

Single tariff (existing meter)	Both EV and non-EV loads	Same existing meter can be used for EV charging User and utility cannot monitor EV consumption (dual source meter is also an option but would require existing meter to be replaced and also these meters are less popular globally) No incentive for night charging and high dependency on import during day-time
ToU tariff (separate meter)	Only EV load	Installation of separate meter required for EV charging User and utility both can monitor EV consumption Utility can influence night charging by changing tariff structure. For example, lower off-peak tariffs and higher peak-tariffs. Smart meters are getting deployed in Ulaanbaatar. The utility can easily implement and encourage EV charging. Only a few countries have implemented seasonal tariffs (winter and summer) for EVs and other connections. However, this structure is not recommended for Mongolia as the EV load, even in a proactive scenario, is quite minimal (i.e. 16 MW) until 2030. Also, the existing tariff framework of Mongolia does not include season-wise tariff. At a broader level, this seasonal tariff needs to target non-EV loads as well which would possibly require overhaul of the tariff framework (e.g. billing system, software, etc.) and extensive stakeholder consultations. Once the seasonal tariffs are introduced, then possibly it can be extended for EVs also.
ToU tariff (existing meter)	Both EV and non-EV loads	Same existing meter can be used for EV charging User and utility cannot monitor EV consumption (dual source meter is also an option but would require existing meter to be replaced and also these meters are less popular globally) Utility can influence night charging by changing tariff structure. For example, lowering off-peak tariffs or increasing peak tariffs or both. Smart meters are getting deployed in Ulaanbaatar. The utility can easily implement and encourage EV charging. Some countries have implemented seasonal tariffs (winter and summer) for EVs and other connections. However, this structure is not suggested for Mongolia as this would require complete overhaul of the existing tariff framework. For dedicated EV tariffs that includes both EV and non-EV loads, this approach is mostly prevalent in developed countries with high EV adoption. These plans are typically introduced at a later stage of EV market growth. Note: This option will lead to a reduced tariff for other non-EV loads which is not a purpose of this tariff design. Henceforth, this tariff needs to be suitably adjusted by considering both EV and non-EV loads.

Tariff option analysis

- 7.58 Options 1 and 2 are not proposed, as their single rate structure will not significantly influence charging behaviour, which is the principal aim of the EV tariff in the Mongolian context.
- 7.59 Of the two ToU tariff options (3 and 4), Option 3 (with a separate meter) is the most appropriate option, and the addition of a meter will have a limited cost in the context of EV charging stations installed in communal residential buildings (as is predominant in the Ulaanbaatar contexts).
- 7.60 The basis of proposed EV ToU tariffs for residential and industrial users are as follows:
- The EV ToU energy tariff for both residential and industrial users is proposed to remain the same given the high dependency on imports to meet energy demand during (making the costs of reducing these prohibitively expensive to the overall system).
 - The basic fee levied to the residential user has been kept unchanged since this is independent of sanctioned load (in kW).
 - The capacity charges levied to the industrial user have been reduced by 67%, considering that lower charger utilisation of charging stations has the impact of greatly increasing the average electricity price (USD/kWh) and potentially make commercial business models unviable for public or dedicated charging station operators. For this reason, many states in India have announced special EV tariffs and reduced demand/capacity charges by 50 to 100 percent to make EV charging affordable.

Opportunities for revenue generation

- 7.61 At present, Mongolia export excess energy to Russia at the rate of MNT 30/kWh during summer season. This is almost one-fifth of residential single tariff (MNT 155/kWh) and one-third of industrial off-peak tariff (MNT 100/kWh). If this excess energy is used for night charging, then utility can generate extra revenue (i.e. export saving) in the range of MNT 70/kWh to MNT 125/kWh depending upon the user and charging locations. Mongolia exports excess energy only during the summer season. Therefore, an adjustment factor of 50 percent¹⁵⁴ needs to be applied to estimate export savings applicable throughout all seasons. The net estimated export savings due to night charging is about MNT 65/kWh for residential and MNT 35/kWh for industrial users.

¹⁵⁴ It is assumed that Mongolia exports energy for six months each year. Therefore, the applicable adjustment factor is 50%.

- 7.62 To remain revenue neutral, this savings can be passed to user as part of discounted tariffs (i.e. dedicated EV tariffs). The expected off-peak tariff (i.e. night-time charging) for residential and industrial users is MNT 90/kWh and MNT 75/kWh respectively. This tariff is almost 40% lower for residential and 30% for industrial user from their base tariff structure. This lower tariff would encourage late night charging across all the locations.

Proposed EV Tariff

- 7.63 The time comparison of existing and proposed EV tariff is shown Table 7-21 below with the detailed rates in Table 7-22. The Base Case position on the figure is the single tariff for residential users (who will opt for single tariff considering tariff structure is simple to understand) and ToU tariff for industrial users who will choose to optimise their energy cost from the business perspective.

Table 7-21: EV tariff comparison: Existing vs Proposed tariffs for residential and industrial users

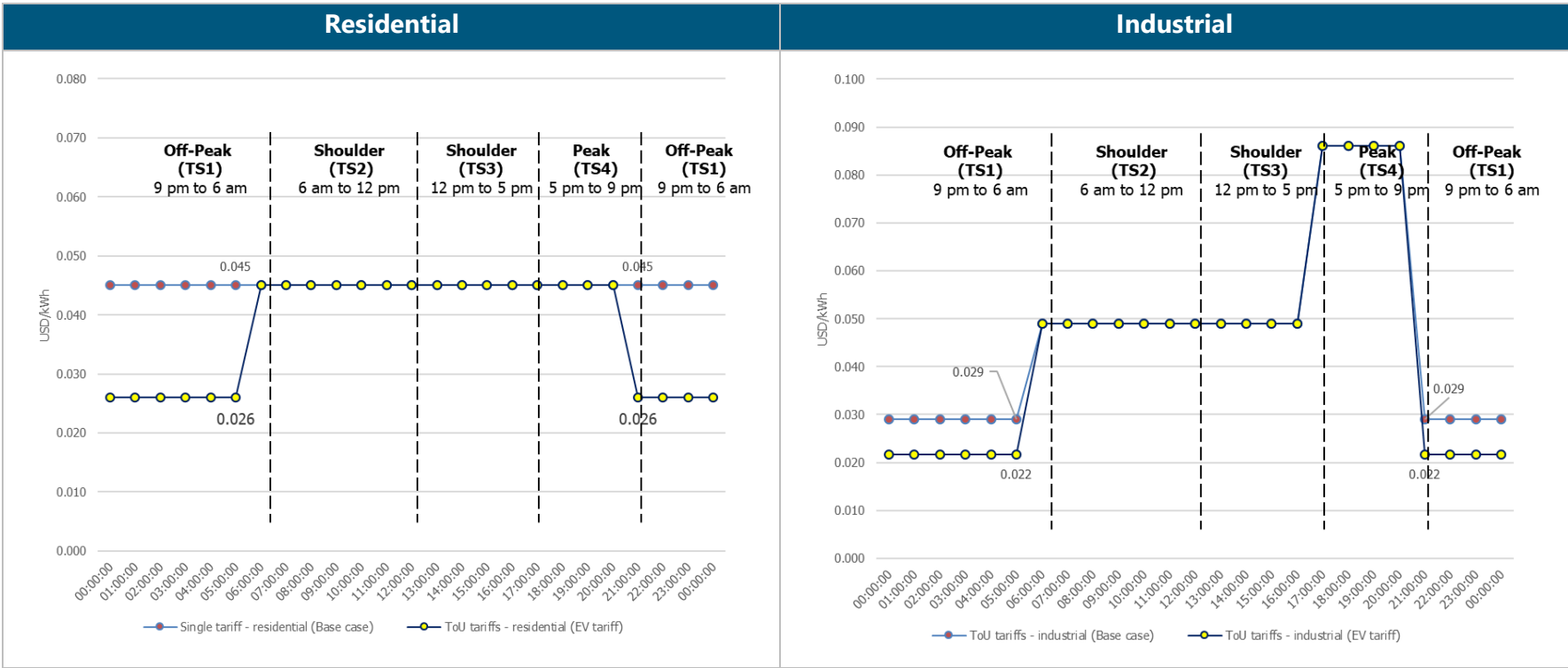


Table 7-22: Proposed EV tariff rates

Category	Fixed charges	Unit	Energy Charges	
Residential- EV tariff (new category)				
Fixed charge	Basic Fee	Per month	USD 0.570 (unchanged)	MNT 2,000
Energy charge	Shoulder (6 am to 9 pm)	Per kWh	USD 0.045 (unchanged)	MNT 155
	Off-peak (9 pm to 6 am)	Per kWh	USD 0.026 (tariff ↓ by 40 percent)	MNT 90
	Peak (not applicable)	Per kWh	N/A	N/A
Industrial- EV business tariff (new category)				
Fixed charge	Capacity charges	Per kW/ month	USD 0.87 (tariff ↓ by 2/3 rd)	MNT 3,000
Energy charge	Shoulder (6 am to 5 pm)	Per kWh	USD 0.049 (unchanged)	MNT 170
	Off-peak (10 pm to 6 am)	Per kWh	USD 0.022 (tariff ↓ by 30 percent)	MNT 75
	Peak (5 pm to 10 pm)	Per kWh	USD 0.086 (unchanged)	MNT 300

Potential impacts for industrial tariff

- 7.64 For the industrial tariff, an example scenario for a commercial charging point in a context of early stage of EV growth as in Mongolia is provided below. Key metrics are:
- Low utilisation rates (10%) with monthly charging load of 3,600 kWh
 - Baseline distribution pattern under a TOU/EV tariff of: Shoulder 70/65% Peak 20/15% and off-peak 10/20%.
- 7.65 As shown in Table 7-23, the outcome of this would be to shift 25% of peak demand to the off-peak period. The operator would save \$87/month in capacity charges and a further US\$19 in energy charges, with an average per kWh cost reduction of 32%.

Table 7-23: Energy and economic impact for public charging

	Unit	As per existing tariff	As per dedicated EV Tariff	Change
Total consumption	kWh/month	3,600	3,600	
• Shoulder	kWh/month	2,520	2,340	(-)180
• Peak	kWh/month	720	540	(-) 180
• Off-peak	kWh/month	360	720	(+) 360
Total capacity charges	USD/month	130	43	87
Total energy charges	USD/month	196	177	19
• Shoulder	USD/month	123	114	(+) 9
• Peak	USD/month	62	46	(+) 16
• Off-peak	USD/month	10	16	(-) 6
Total electricity bill	USD/month	326	220	106
Capacity charges	USD/kWh	0.036	0.012	0.024
Energy charges	USD/kWh	0.054	0.049	0.005
Net electricity cost	USD/kWh	0.090	0.061	0.029

Potential impacts for a residential user

7.66 For a residential user, the key scenario metrics are:

- Monthly consumption of 300 kWh¹⁵⁵
- Baseline/EV tariff demand distribution is Shoulder (25%/25%), Peak (50%/35%) and Off-peak (25%/40%)

7.67 The overall outcome of the impact of the EV charging tariff is shown in Table 7-24. It would shift 30% of peak EV demand to the off-peak period. It would result in a total monthly saving the user of \$2.27 compared to the standard single tariff.

¹⁵⁵ Assumption: Monthly travel distance- 1,500 km and vehicle efficiency- 5 km per kWh i.e. (20 kWh/100km)

Table 7-24: Energy and economic impact for residential charging

	Unit	As per existing tariff	As per dedicated EV Tariff	Change
Total consumption	kWh/month	300	300	
Shoulder	kWh/month	75	75	No change
Peak ¹⁵⁶	kWh/month	150	105	- 45
Off-Peak	kWh/month	75	120	+ 45
Total capacity charges	USD/month	0.57	0.57	No change
Total energy charges	USD/month	13.50	11.23	2.27
Shoulder	USD/month	3.38	3.38	No change
Peak	USD/month	6.75	4.73	(+) 2.03
Off-Peak	USD/month	3.38	3.13	(+) 0.24
Total electricity bill	USD/month	14.07	12.08	2.27
Capacity charges	USD/kWh	0.002	0.002	No change
Energy charges	USD/kWh	0.045	0.037	0.008
Net electricity cost	USD/kWh	0.047	0.039	0.008

7.68 For time-of-use (ToU) residential EV tariffs, that includes both EV and non-EV loads, the night charging incentive needs to be provided to the extent of EV load consumption only. In that case, off-peak tariff of MNT 90/kWh (under proposed EV residential EV tariff) can be increased to MNT 100/kWh or higher. For simplicity if a user wants to use both loads using single meter, in such case it is mandatory for them to opt existing ToU residential tariffs.

¹⁵⁶ In Mongolia, residential tariffs do not differentiate between peak and shoulder periods, applying the same rate for both, while industrial tariffs have distinct rates for each period. For reporting consistency, residential user analysis is presented for three periods: shoulder, peak and off-peak.

Impact of proposed EV Tariff

7.69 The estimated impact of EV tariff for different stakeholders are summarised in Table 7-25 below.

Table 7-25: Summary of EV tariff impacts by stakeholder

Stakeholder	Impact
Users	Residential 16% reduction in average electricity price (USD/kWh). Monthly savings¹⁵⁷ of US\$2.3 per month. Industrial 32% reduction in average electricity price (USD/kWh) compared to existing ToU tariff applicable. Monthly saving of US\$106 per month to operator.
Utility	Dedicated ToU tariffs encouraging night charging has potential to shift demand up to 30%, reducing actual impact on the national grid. The revenue generated from energy used for EV charging will be higher than the revenue that would have been generated from exporting that energy at cheap rates (an additional revenue of MNT 35/kWh for residential and MNT 65/kWh for industrial EV charging, accounting for seasonal adjustments). Additional metering cost assumed to be borne by the utility (may be recovered through capacity or basic fee) although some countries directly charge meter cost to user.

¹⁵⁷ The monthly savings depend on several factors such as total consumption and charging patterns, and would vary from user to user

Government	The revenue generated from those on the “EV tariff” for the energy they use overnight (when their energy is cheaper), for all purposes other than EV charging, will be less than it would have been if they were on the normal tariff. However, there will be revenue generated from the additional energy used to charge EVs, in comparison to that energy’s export value (as that energy would otherwise have been exported cheaply overnight). The revenue lost from EV owners’ ordinary electricity usage overnight is approximately equivalent to the revenue gained from them charging their EVs, rather than exporting that energy at a lower rate. So, the EV tariff could be self-sufficient. If consumers can be encouraged to shift more of their energy usage (beyond EV charging) from the peak to overnight because of the EV tariff, increasing EV use could reduce the need for energy imports during the peak.

EV Tariff Implementation

Key stakeholders

- 7.70 The implementation of the dedicated EV tariff will require coordination between MOE, ERC and energy distributors (primarily UBEDN). Establishing this new tariff regime involves the integration of new ToU EV tariffs into the regulatory framework, followed by its operationalisation with energy distribution networks.

Metering technology

- 7.71 With respect to metering technology, smart meters are widely adopted globally and are increasingly being rolled out in Mongolia. Smart Meters can differentiate between non-EV loads and EV loads, allowing for precise billing and monitoring of both types of consumption. The various types of meter options available for EV charging connections are shown in Table 7-26 below.

Table 7-26: Metering technology recommendations

Meter type	Reference image	Brief description	Typical cost ¹⁵⁸ (USD)	Applicability to EV charging

¹⁵⁸ The cost of an electric meter varies based on the type of meter, installation fees, regulatory requirements, and ongoing maintenance expenses. When considering a meter upgrade or replacement, it’s essential to consult with your local utility company to get accurate cost estimates and ensure compliance with local regulations.

Analog meter		This is a traditional meter and typically has a rotating disc for energy measurement. Requires manual meter readings.	\$50 - \$100	Yes, possible depending on utility but given advancements in smart meters and potential benefits it is not preferred
Smart meter ¹⁵⁹		A digital device that records electricity consumption and can communicate the information to the utility on real-time basis. Eliminates the need for manual meter readings.	\$100 - \$300	Yes, and dominantly used globally
Smart dual meter		This meter offers functionality of two meters in one advanced device for energy consumption measurement (For e.g. power and gas, etc.)	\$300 - \$500	Applicable, but since it is costlier it is less prevalent for EV charging. They allow features like V2G and vice versa for EV owners.

7.72 It is recommended to deploy a separate electricity connection for EV charging, which necessitates the installation of a new smart meter at the user's premises with proposed EV ToU tariff. This will help the utility to understand the user's charging pattern and

¹⁵⁹ SmartMeterTM. (n.d.). <https://www.pge.com/en/save-energy-and-money/energy-saving-programs/smartmeter.html#:~:text=SmartMeters%E2%84%A2%20measure%20and%20record,your%20hourly%20electricity%20usage%20online>.

thereby manage the demand/load to be able to meet that requirement and better strategies for integrating EVs into the power grid. Considering Mongolia's advancements in smart meter deployments and ongoing expansions (i.e. target of reaching 30% smart meter connections by 2024¹⁶⁰), it appears feasible for the country to consider integrating smart meters for EV charging solutions.

- 7.73 For home or residential charging, users have the option to install an additional meter specifically for EV charging, allowing them to benefit from lower EV Time-of-Use (ToU) rates. Alternatively, they can use their existing meters also for EV charging, but this would preclude them from accessing the EV ToU tariff benefits. Public and dedicated charging stations, on the other hand, will require a single EV meter connection. The process and guidelines for issuing a new EV connection for EV can follow similar procedures to those for existing electricity connections in Mongolia.
- 7.74 As part of the EV connection issuance process, the utility needs to consider verifying whether the user owns an EV. Utilities must implement a reliable verification process, which may involve requiring users to provide proof of EV ownership, such as vehicle registration documents or purchase receipts. Additionally, utilities might consider on-site inspections or remote monitoring to confirm that the EV is actively being charged at the specified location. This verification is crucial to ensure that only eligible users can benefit from EV-specific tariffs and incentives.

Recommendations

- 7.75 In conclusion, this study recommends proceeding to implement an EV charging tariff for both residential and industrial uses. Global experiences show the importance of coordinating the development of the EV sector with power grid developments to ensure that new connections align with the wider utility grid-planning. A well-designed EV tariff structure and implementation can address the increased energy demand from EVs. While energy demand from EVs to 2035 is expected to remain a small proportion of overall energy demand, the development and refinement of strong demand management structures in these early stages can lay the groundwork for the impacts of future mass EV deployment.
- 7.76 For commercial charging points, the EV tariff will be more immediately critical, ensuring that the public charging point business model is commercially viable during the early stages of electrification, when utilisation rates are relatively lower. For private EV users, price signals around energy cost can also serve as a key lever to promote and create more awareness around e-mobility adoption.

¹⁶⁰ Based on consultation with ERC

- 7.77 From an implementation perspective, Ulaanbaatar Energy Distribution Network (UBEDN) will need to invest in smart meters, although this investment is proposed to align with existing smart meter expansion plans¹⁶¹.

RE Energy Enhancement and Integration

Introduction

- 7.78 Mongolia's energy grid emissions reduce the effectiveness of e-mobility in decarbonisation in all segments (indeed for e-buses, they potentially negate them) and in the current governance arrangement there is no end user market for RE to enable EV operators and CPOs to reduce their carbon intensity. While microgrid solutions may be suitable for some applications, they are not practical or feasible in all cases, and it is therefore necessary to explore the potential to decarbonise grid-based EV charging, particularly as EVs scale up.
- 7.79 The overall objective of these recommendations is to develop a market-driven end user market for RE which, based on a competitive end-user RE market will lead to an improved investment environment for RE developers. Decarbonising EV charging will require major reforms to the Mongolian energy regulatory framework which, in order to be technically, economically and institutionally feasible, would need to go beyond the EV charging sector alone (which at 2035 would represent 0.2-2% of demand) to explore how wider grid decarbonisation can be pursued for all users.

EVs in the context of wider grid decarbonisation

This study recognises the wider context for energy reform in Mongolia, including challenges in the expansion of renewable energy and efforts to increase the rate of cost recovery. These recommendations contribute to that policy agenda. However, it is recognised that they form a small part of the whole. Nevertheless, it is important to highlight that if the current challenges in grid decarbonisation are not overcome, the case for the proactive promotion of e-mobility is significantly weakened.

RECOMMENDATION S10: Create End-User Market in Renewable Energy through the Grid

- 7.80 In order for e-mobility to effectively decarbonise the transport sector, it will require the current grid vehicle users and charging point operators to reduce their carbon intensity

¹⁶¹ Based on consultations with ERC, they intend to install additional ~139,000 smart meters in 2024 and plan to expand their smart meter deployment further in the coming years.

(without the use of off-grid renewables). The current apportionment of green energy rates to all users (and their high cost) presents policy conflict for the energy system, which is torn between maintaining low energy costs and expanding renewable energy provision.

Enable open trading of RE between generators and certain consumers

- 7.81 This study recommends changes to the energy regulatory framework to allow a marketplace through which RE developers can sell power openly in market. This will effectively come out of Single Buyer model, at least for certain sizes and/or categories of energy users.
- 7.82 The Single Buyer model¹⁶², adopted within Mongolia's Energy System, is regulated by an automatic cash flow mechanism¹⁶³ and significantly relies on central planning for decision making. This model restricts the purchase of RE power exclusively by government or distribution utilities and therefore prevents end users/ consumers to purchase RE directly.
- 7.83 This model also lacks the flexibility to introduce competition and does not promote accountability of the distribution utilities (Discoms) for long-term operational efficiency. For instance, the payments to generating companies are contingent upon amounts collected by Discoms, which may sometimes fall short of the owed amounts¹⁶⁴. This has impact on overall investors sentiment and may delay RE development in the country including e-mobility and charging.
- 7.84 Mongolia should amend its current regulatory framework to allow RE developers to sell power directly also in the market (i.e. to end users/ consumers). This should be limited to specific user segments of a minimum demand threshold, and include EV charging station operators (with high load requirements). It is recommended that the direct market for RE energy should include direct negotiation of pricing between RE generators and users. This will not only enable a market for green energy but also catalyse competition among RE sellers, enhancing economic viability and the attractiveness of RE sources over time. To facilitate open power sales, regulations for the wheeling of electric power need to be established. This includes determining wheeling charges for entities that utilize transmission and distribution facilities to deliver power from generators to end users. The prospect of open power sales will also

¹⁶² Mongolia's energy sector operates under the framework of the "Single-Buyer Model", where a single wholesale buyer of electricity can choose from a number of different generators, with retail monopolies to consumers based on regionally determined distribution networks (which also act as retailers).

¹⁶³ ERC. (n.d.). *Single buyer model*. <https://erc.gov.mn/web/en/single-buyer-model>

¹⁶⁴ Batzaya, B., & Chojiljav, N. (2020). Features of the Mongolian Electricity Market. *E3S Web of Conferences*, 209, 05027. <https://doi.org/10.1051/e3sconf/202020905027>

attract domestic and international investment, fuelling accelerated growth and progress within the RE sector.

- 7.85 Examples of energy markets with similar arrangements include Mexico (with 'qualified users' over 1MW of demand) and Kazakhstan (which also has retail competition for larger operators). Argentina and Chile offer variations of the single buyer model, where the system facilitates transactions between sellers and large customers via long-term contracts. However, distribution wires and companies remain regulated in these models.

Case Study: Mexico's Energy Reform

- 7.86 Mexico's 2013 Energy Reform saw the establishment of a new electricity market in what was a heavily state-led single buyer model previously. Under the new structure multiple participants, including generators, suppliers, and traders, can engage in buying and selling electricity. One of the main features of the new electricity market is the introduction of auctions for the procurement of electricity supply contracts. These auctions allow generators, including renewable energy developers, to compete for contracts to supply electricity to the grid. This competitive process has helped drive down electricity prices and increase transparency in the sector. The reform also allows Qualified Users (registered users with a demand above 1MW) to purchase energy in an open market. Other users (including residential users) remaining a Single Buyer model under the state operator, Federal Electricity Commission (CFE).

Enable transparency in RE dispatch

- 7.87 There have been transparency issues where the RE law stipulates, on one hand, that the system is obligated to receive the energy supplied by RE generators, but on the other hand, the system dispatcher has the right to dispatch and consequently may refuse such energy. The matter of obligating to compensate for curtailed energy could be managed by a transparent, universal regulation, but instead is managed by stipulations of the Power Purchase Agreements (PPAs). This leads to the potential for unfair and inequitable treatment of RE generators (or at least a perception on the part of investors).
- 7.88 There can be regulatory provision to award RE projects as a "must run" status to overcome the dispatch issue. i.e. generation from RE has higher priority than power generated from CHPP. This will also mitigate the conflict of interest arising to optimise power purchase cost due to primarily tariff difference between the two sources (RE is min. 5 times higher than CHPP). To enable the priority dispatch of RE, technical issues related to grid operation must be overcome, ensuring the grid has sufficient flexibility

to manage the uncertainty and variability of RE output. An advanced power system operation system, capable of remote monitoring and control of the grid and generators, is also a necessary prerequisite.

Introduce Renewable Purchase Obligation (RPO) targets for distribution network operators and high-consumption industries/users

- 7.89 It is recommended to develop a scheme of Renewable Purchase Obligations (RPO) as a regulatory mandate. These would require obligated entities (different user categories) and potentially distribution networks to procure a minimum proportion of their total energy consumption from RES, thus creating a functioning market in RES.
- 7.90 In definition of the RPO schemes, various mechanisms can be included for meeting the obligations, including: on-site generation of green power by the user; procuring energy from RE developers; or trading in green certificates without actual RE procurement. Such measure serves to stimulate demand for RE and also incentivize the deployment of more projects by creating a secure market (i.e. both public and private) for developers. It is not recommended that EV charging operators are included in these RPOs on account of their small scale and that it would increase their cost base, however where certified GHG mitigation impacts are required, trading in green certificates (e.g. purchased from an RPO obligated entities as part of a secondary market) may be appropriate.
- 7.91 Typically, RPO targets are established annually and across various RE sources, aligned with developments and goals in RE generation. The efficacy of this mechanism depends on several factors, including discoms' and consumers' perceptions of the competitiveness of renewable energy (wind, solar, hydro, etc.) relative to conventional fossil fuels, the adequacy of grid infrastructure for RE integration, and the presence of robust compliance mechanisms. Therefore, it may be prudent for the country to initially set modest RPO targets, progressively increasing them over time.
- 7.92 RPOs have been effectively implemented in India, with a gradual increase reaching ~23% in 2023 from 2.75% in 2016. The revised targets established by the government in 2024 aim to further achieve the targets to 44% by the fiscal year 2029-2030.
- 7.93 Implementation of RPOs in Mongolia will need the buy-in and leadership of MOE and ERC, alongside wider system actors. It will be key to establishing feasible targets while defining transparent and systematic RPO compliance mechanisms among entities including distribution companies and obligated entities.

RECOMMENDATION S11: Strengthen Investment Climate for RES Development to Enable Wider Grid Decarbonisation

Improve access to financing and reduce payment risks for developers

- 7.94 The RE sector in Mongolia grapples with significant financing challenges. A 2015 survey by the Government of Mongolia highlighted high interest rates and rigorous collateral prerequisites as the principal financing challenges. Risk levels are increased on loans denominated in Mongolian Tugrik (MNT) due to historic currency volatility, high inflation rates, and an unstable policy environment. Reported interest rates for RE investments fluctuated widely from 5% to 42% per annum (averaging around 22%) which also leads to short loan tenures¹⁶⁵. Many larger RE projects turned to concessional financing from international institutions, either directly or through domestic partners.
- 7.95 While Mongolia has policy commitment to RE development, there have been a number of implementation challenges (including around the RE Fund, the FiT system and payments, and project level approvals and payments issues). As a result, the investment community has perceived an increasing non-payment risk.
- 7.96 To address the challenges faced by the developers, the government needs to consider and implement measures to boost domestic financing for RE projects by providing long tenure loans at lower interest rates. Additionally, to mitigate payment and project approval risks, the government can establish a dedicated RE nodal agency responsible for monitoring and managing issues encountered by developers.
- 7.97 The government has also introduced RE levy (green surcharge for users 0.0068 USD/kWh) through RE law, intended to recover revenues sufficient to pay for new RE systems. This surcharge needs to be reviewed to ensure that the total payments received from users are sufficient to make timely payments to developers. The combination of these measures can ensure the developers risks are better managed leading to lower RE prices.

Government to phase-out Subsidies to Fossil Fuel Generators

- 7.98 Mongolia's economy is heavily reliant on the production of coal, which contributes significantly to its export revenue, and 90% to its power generation needs¹⁶⁶. The country also has some of the lowest end-user electricity tariffs in Asia (e.g., US \$0.06 for

¹⁶⁵ Government of Mongolia. (2015). *Investment plan for scaling-up renewable energy in Mongolia*. https://www.cif.org/sites/cif_enc/files/srep_ip_mongolia_final_14_dec_2015-latest.pdf

¹⁶⁶ *Mongolia's clean Energy transition: a pathway to sustainable and inclusive development*. (n.d.-b). UNDP. <https://www.undp.org/mongolia/blog/mongolias-clean-energy-transition-pathway-sustainable-and-inclusive-development>

industrial users and US\$0.05 for residential users). CHPP generation costs are low in significant part due to the existence of significant subsidies on domestically produced coal¹⁶⁷. While low energy cost and thermal generation are considered to serve a social purpose (providing not only low-cost energy but also heating and hot water in winter), this nevertheless distorts the energy market away from RE generation and leads to a perception on the part of privately-owned RE generators that there is the potential for CHPP's to be favoured in future strategy.

- 7.99 The government needs to consider comprehensive energy sector reform plan with clear long-term objectives and economic analysis from a level playing field from a starting point without subsidised coal inputs and considering how the benefits of energy subsidy can be best targeted to vulnerable user groups as well as other social objectives including decarbonisation. While removal of subsidies related to local industry is a challenge most energy producing countries, other countries have done this. Saudi Arabia for example has phased out explicit electricity subsidies, leading to ~70% of customers reducing their electricity usage. This reduction in consumption will also decrease conventional power generation for local consumption, thereby resulting in environmental benefits and investment cost savings¹⁶⁸.
- 7.100 Another approach would be the application of carbon pricing for all energy generation. For example, the EU Emissions Trading Scheme (EU ETS)¹⁶⁹ sets carbon prices for power plants as part of its market-based approach to reducing greenhouse gas emissions. Under this scheme, power plants and other industrial installations are allocated a certain number of emission allowances, each representing the right to emit one tonne of carbon dioxide or its equivalent. If a power plant emits more carbon than its allocated allowances, it must purchase additional allowances on the carbon market to cover its excess emissions. Conversely, if a power plant emits less than its allocated allowances, it can sell its surplus allowances to other participants on the market.

Lower RE Capex Cost

- 7.101 Following the consultation with a solar developer and public energy stakeholders, there is concern that RE capital investment costs (and therefore energy costs) are high by international benchmarks. It is understood that the capital expenditure (CAPEX) for 1 Megawatt peak (MWp) of solar energy plant in Mongolia is ~1.5 million USD, more

¹⁶⁷ World Bank. (n.d.). *Mongolia – Capacity Building and Regulatory Support Technical Assistance Project Document*. <https://pubdocs.worldbank.org/en/25944153155593596/4106-XSREM057A-Mongolia-Project-Document.pdf>

¹⁶⁸ Mekelberg, Y. (2018, August 9). *Saudi energy subsidy cuts an early success*. Arab News. <https://www.arabnews.com/node/1353116>

¹⁶⁹ EU Emissions Trading System (EU ETS). (n.d.). Climate Action. https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets_en

than double the CAPEX compared to trends in India and other regions average¹⁷⁰. This higher capex is attributed to several factors as follows: a) heavy reliance on imported solar panels, inverters, and other components, which incur import duties, taxes; b) volatile lending market and higher interest rates; c) lack of periodic reviews on FiTs structure for RES; d) limited scale of deployment and hence economies of scale and e) remote geographical location and lack of grid infrastructure for RE generation

7.102 To address these issues, the government needs to engage in deliberate discussions with private developers to explore how RE capex costs can be reduced. This could include reviewing taxes/duties structures, system costs, financing costs (e.g. with low-concessional rates from donors/multilaterals or through the establishment/expansion (if already available) of sustainable energy financing facilities), supply chain efficiencies and long-term planning/pipeline development. Of key importance will be instilling confidence in the long term institutional and financial stability of RE in Mongolia, reducing risk premiums and improving viability of utility-scale RE projects.

7.103 Mongolia possesses immense potential for renewable energy, particularly in wind and solar power. However, most of these RE resources are situated in remote areas far from the capital, Ulaanbaatar. This geographical challenge is compounded by the lack of high-voltage transmission links between these resource-rich remote areas and Ulaanbaatar. The absence of such infrastructure has hindered the development and utilisation of renewable generation in these regions. The future development of renewable energy generation, facilitated by the transmission infrastructure from Ulaanbaatar to remote regions will improve grid connectivity and enable the efficient transfer of electricity generated from renewable sources to urban centers, thereby reducing generation costs and CO₂ emissions.

RECOMMENDATION S12: Pilot Roll-Out of Captive RE Integration for Public Transport E-Buses

7.104 In the short-medium term, captive RE integration for BEB charging will be key to decarbonising the e-bus sector. The use of captive RE for e-bus charging will also help to reduce the grid demand from this sector, reducing the required grid investment. The existing RE sector in Mongolia will be well placed to support the implementation of e-bus charging facilities, although it will require close collaboration with MUB PTD and bus operators to define the legal and contractual mechanisms through which long term RE investments (25-year lifespan) can be aligned with bus service contracts

¹⁷⁰ Based on discussion with Mongolia and India RE developers

(currently one year) and BEB lifespan (12 years). This is explored in the e-bus business model review and recommendations.

- 7.105 In practical terms, to successfully implement this system it will be crucial to address challenges such as the high investment costs for using batteries to store RE for overnight charging, scheduling fleets to match charging patterns with RE generation, and finding suitable locations for on-site RE installations.

8. Environmental Recommendations

RECOMMENDATION S13: Incorporate E-Mobility Targets into Environmental Target-Setting and Policymaking

As articulated throughout this study, e-mobility in Mongolia is not an end to itself, and support and management of e-mobility must consider how it can support policy goals. While the main initiatives and incentives sit within the transport and energy sector, the principal potential benefits and policy drivers for e-mobility are environmental: decarbonisation and reduction of local pollutants (particularly as they manifest in urban air pollution).

To ensure that transport and energy investments and policies to support e-mobility align with these benefits, impact targets for e-mobility will be important to ensure that implementation of the roadmap is achieving its anticipated effects. This should include planning and investment prioritisation at the national level (e.g. insertion in Vision 2050 and updating the four-year Action Plan) and city level (e.g. upcoming sustainable mobility planning exercises).

Mongolia should also include the decarbonisation impacts of its e-mobility ambitions into future NDC updates. This will both demonstrate its ambitions in the sector and commitment to low carbon e-mobility, as well as supporting Mongolian stakeholders to leverage climate financing for the roadmap implementation.

Finally, incorporation and monitoring of GHG and other air pollution targets related to e-mobility into national planning will enable evidence-based decision making on e-mobility relative to other policy options to address the same goals, such as fuel standards, modal shift, and energy investments.

Battery Reuse and Recycling

The challenge of battery waste management

- 8.1 The disposal of EV battery waste is a growing concern around the world as EV adoption grows. Batteries contain highly toxic and flammable chemicals, meaning they should not be disposed of in landfill for both environmental and public safety reasons. Furthermore, disposing of batteries in landfill also wastes an opportunity for value

recovery, environmental impact reduction and resource security improvement through battery recycling and repurposing¹⁷¹.

- 8.2 The prevalence of hybrid electric vehicles (HEVs) in Mongolia, most of which are used with limited battery life remaining, already poses a battery waste challenge. In 2019, it was estimated that 38.43 tons of high-voltage battery waste was generated annually by HEVs in Mongolia, according to a report by local consultancy SICA for MRTD. No recycling facilities exist locally, and overseas recycling is frustrated by the challenge of re-export of life-expired vehicles across the border to China.
- 8.3 Considering that the battery of a BEV (e.g., Nissan Leaf) is 10 times larger than a hybrid vehicle (e.g., Prius), MRTD is conscious of the urgency of addressing this challenge within EV policy. However, existing regulation on EV battery waste is limited and lacking in clear guidance for EV stakeholders.
- 8.4 To provide an indication of the scale of long-term end of life battery volumes, the number of EV automobiles up to the age of three (broadly 'new' and 'mid-range' EVs) estimated to be imported in 2035 by our modelling (approximately 6,500) will in ~15 years after import (~2050) generate around 2,000 tonnes of battery waste¹⁷² / 200,000 kWh of battery power for possible re-purposing. For EV automobiles over the age of three ('mass market'), the estimated imports in 2035 (approximately 50,000) will in ~7 years after import (~2042) generate ~15,000 tonnes of battery waste / 1,700,000 kWh of 200,000 kWh of battery power for possible re-purposing.

Global trends in battery waste management

- 8.5 While there is rapid development of recycling technologies and capacity in many EV growth markets (e.g. China, USA), globally it is estimated that only 5% of end-of-life EV batteries are currently recycled¹⁷³. This means best-practices for EV battery waste management are still being designed and refined, and existing processes will need to be scaled-up. In broad terms, two key drivers exist for battery recycling: Extended Producer Responsibility (EPR) with tracing, and market-based models.

¹⁷¹ UK Government. (2023, November 21). *What are the technical and policy barriers to increasing EV battery recycling capacity in the UK?* GOV.UK. <https://www.gov.uk/government/publications/electric-vehicle-battery-recycling-capacity/what-are-the-technical-and-policy-barriers-to-increasing-ev-battery-recycling-capacity-in-the-uk>

¹⁷² Using BAIC EU 5 as a typical automobile battery weight - ~300kg. BAIC. (n.d.). *EU5 specifications*. https://www.baicglobal.com/file/upload/2022/08/12/EU5%20Specifications_20220812130509A021.pdf

¹⁷³ Woollacott, E. (2021, April 26). *Electric cars: What will happen to all the dead batteries?* BBC News. <https://www.bbc.co.uk/news/business-56574779>

EPR and tracing

- 8.6 Many countries have implemented EPR as part of their battery waste management regulations, including Mongolia's Law on Waste. This sees battery manufacturers responsible for the recycling or end-of-life management of life expired EV batteries.
- 8.7 For this to be effective, battery traceability is necessary to identify the responsible party for an EV battery at the end of its life. By 2026 the EU will have passed the new European Battery Regulation, requiring all batteries to have a passport to be sold in the EU economic area. This will help for the waste management process of any battery to be monitored and enforced correctly. China and the US have also developed similar approaches to combat this issue, with China enacting a set of policies that put responsibility on the manufacturer or importer for the batteries. The policy directs manufacturers to provide technical information on storage and management and to design batteries that enable easier recycling¹⁷⁴. In cooperation with Everledger, the US has also created a platform to trace batteries throughout their lifetime¹⁷⁵.
- 8.8 Battery leasing, a business model used primarily to reduce the upfront costs of EVs, is also supportive of end-of-life battery accountability. In this model, the battery is kept under the ownership of a third party, with the responsibility falling not on individual owners but upon a smaller number of third-party financiers.

Market based options for recycling

- 8.9 There is a significant financial incentive to recycle batteries due to the value of the rare earth metals in EV batteries. For example, the UK's EV fleet contains over 1,400 tonnes of lithium and 800 tonnes of cobalt, worth £26.3 million and £31.5 million respectively¹⁷¹. A circular economy in EV batteries also helps to address the challenge of a finite reserve of rare earth metals for batteries. Based on current battery technology, it is thought that about half of all current global reserves would need to be mined to meet the demand from EVs¹⁷⁶. At a global scale, EV battery recycling can therefore improve the longevity of EVs as a mobility solution.
- 8.10 As such, market-based solutions can encourage the development of a market in EV battery recycling in order to recover rare minerals. Several processes exist for EV battery recycling, but the current most prevalent process is the pyrometallurgical recycling pathway, in which lithium-ion battery cells or modules are directly put into a

¹⁷⁴ EV battery recycling. (2021, February 11). Union of Concerned Scientists. <https://www.ucsusa.org/resources/ev-battery-recycling#read-online-content>

¹⁷⁵ Everledger. (2022, August 4). Battery - Everledger. <https://everledger.io/industry-solutions/batteries/#:~:text=In%20coordination%20with%20a%20grant,greater%20security%2C%20privacy%20and%20traceability>

furnace and smelted at a high temperature. This results in 'black mass', a mixed metal alloy, including cobalt, copper, nickel, and sometimes iron. In subsequent processes, the rare minerals can be recovered, leaving behind a hazardous slag that may need to be disposed of in special facilities. Economic analysis from Belgium, China, the United Kingdom, the United States, and South Korea find that costs/profits from recycling range from -\$21.43 to +\$21.91 per kWh¹⁷⁶.

Recycling options for Mongolia

- 8.11 While Mongolia's "Law on Waste" states that distributors and importers of EVs are responsible for collecting used EV batteries for recycling (EPR), the detailed processes or procedures to operationalise this are not defined. More fundamentally, there is no practical pathway for battery recycling in Mongolia given that the local market size is too small to sustain domestic recycling while overseas recycling depends on permissions for their re-export which it is understood do not currently exist.
- 8.12 Mongolia has a number of years before the end-of-life EV battery challenge becomes a significant concern (nothing that recycling best practice will have advanced significantly by this point), however it is important to have vision for the likely future strategy. The most practical current options are:
- **Short-medium term: Promote second life battery uses**, to promote the longevity of EV battery life for Battery Energy Storage Systems (BESS), urban infrastructure (street lighting, EV chargers, parking meters, etc) and other uses.
 - **Medium-long term: Develop pathways to EV battery recycling** suitable for the Mongolian market size and characteristics. While there may be a role for battery traceability and collection models, the greatest challenge will be to develop with neighbouring countries mechanisms for used battery export, either as used batteries or through a 'hub and spoke' model through which battery incineration facilities are created in Mongolia and then exported for processing.

RECOMMENDATION S14: Encourage Second Life Uses for Used EV Batteries (short-term)

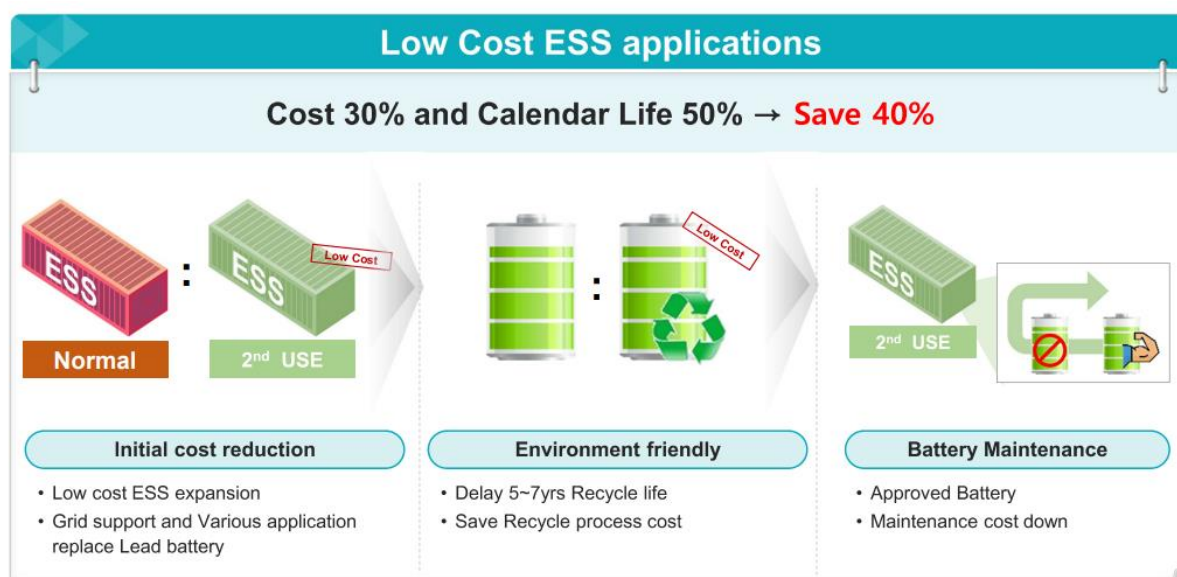
- 8.13 Second life uses for end-of-life EV batteries will generate value for used EV batteries, which may well retain 60-80% of their power at the end of their EV life. These can be

¹⁷⁶ Tankou, A., Bieker, G., Hall, D., & International Zero-Emission Vehicle Alliance. (2023). *SCALING UP REUSE AND RECYCLING OF ELECTRIC VEHICLE BATTERIES: ASSESSING CHALLENGES AND POLICY APPROACHES* (International Council on Clean Transportation, Ed.) [White Paper]. International Council on Clean Transportation. <https://theicct.org/wp-content/uploads/2023/02/recycling-electric-vehicle-batteries-feb-23.pdf>

put to many applications, as shown in Table 8-1 below from ICCT¹⁷⁷. The key challenges to this tend to be around the collection, testing and standardisation of batteries for these uses.

- 8.14 Many EV manufacturers have BESS or other second life use pilots, research or even commercial deployment. Opportunities for application in Mongolia with existing examples elsewhere include peak-shaving applications (either through utility-scale BESS or localised in EV charging points), or applications for back-up storage for the mining sector.
- 8.15 In addition to the commercial and energy sector benefits of second life applications, this will reduce the lifetime embedded carbon emissions from EV batteries and shift the critical mass of end-of-life EV batteries to a later date when technology is more advanced. Figure 8-1 provides indicative benefits of how second life battery applications can support creation of low-cost energy storage solutions whilst extending the useful life of EV batteries 5-7 years beyond their EV use.

Figure 8-1 Use of used EV batteries for ESS¹⁷⁸



Source: Dr Yu Tack Kim

¹⁷⁷ Tankou, A., Bieker, G., Hall, D., & International Zero-Emission Vehicle Alliance. (2023). *SCALING UP REUSE AND RECYCLING OF ELECTRIC VEHICLE BATTERIES: ASSESSING CHALLENGES AND POLICY APPROACHES* (International Council on Clean Transportation, Ed.) [White Paper]. International Council on Clean Transportation. <https://theicct.org/wp-content/uploads/2023/02/recycling-electric-vehicle-batteries-feb-23.pdf>

¹⁷⁸ Asia-Pacific forum on Green and Low-Carbon Development Forum. (n.d.). *The number of end of Life EV battery in Korea*. https://events.development.asia/system/files/materials/2021/10/202110-ev-ess-battery-reuse-re-fabrication-and-recycle-technology-south-korea_0.pdf

Table 8-1: Application of second life uses for end-of-life EV batteries (ICCT¹⁷⁷)

	Project Lead(s)	Location	Year Announced/operation Started
Street Lighting	Nissan	Namie, Japan	2018 (project launch)
Electric Vehicle Charging Stations	Jaguar Land Rover and Pramac	Gaydon, United Kingdom	2022 (operation started)
	Volkswagen and Electrify America	United States	2022 (announced)
Maritime and Airport	The Seine Alliance and Renault	Paris, France	2019 (operation started)
	Neoline Développement	Nantes, France (headquarters)	2020 (pilot project launched)
	Carwatt and Renault	Coignières, France (headquarters)	2014 (operation started)
Industrial Site	RWE and Audi	Herdecke, Germany	2021 (pilot project launched)
	Renault and Connected Energy	West Sussex, United Kingdom	2018 (announced)
Utility-scale Grid Storage	Renault	France and Germany	2018 (announced)
	Enel and Nissan	Melilla, Spain	2019 (in operation)

Case Study: Use of Nissan Leaf batteries for energy storage¹⁷⁹

- 8.16 As the number of used EV batteries grows, commercial applications for second life uses are being developed. This example from the US, by B2U Storage Solutions, uses 20 Nissan LEAF batteries (all in their original cases) to provide 4MWh of storage to a 1 MW solar farm. This allows the energy generator to store energy to sell to the grid at peak usage times, when prices climb.



RECOMMENDATION S15: Develop EV Recycling Pathways, Potentially Using a Hub and Spoke Model (long-term)

While Mongolia has a clearly defined EPR regulation in the Law on Waste, the principal challenge will be around the implementation of logistical pathways for EV battery recycling. In the short-medium term, this will require the negotiation of regulations on export of EV batteries to recycling facilities in neighbouring countries, given the absence of these in Mongolia (or sufficient market to sustain them). China is the logical export market, given its status as a major battery manufacturer and producer of EVs imported to Mongolia. In the short term, it will be necessary to work with EV distributors in Mongolia to develop the process of collection and export and develop the financial mechanisms for this (since it is assumed it will not be profitable in early stages due to heavy weight, long distances and safety regulations).

As the EV market develops, Mongolia should explore whether local battery smelting could be a more efficient and market-based option through which EV batteries are incinerated to convert them to black mass and exported for processing and reuse in battery manufacturing (likely in China, given its proximity and market dominance at present¹⁸⁰, although India is likely to grow significantly in the medium-term¹⁸¹), reducing the logistics costs. This could be considered as an opportunity to attract foreign

¹⁷⁹ Morris, C. (2021, October 26). *This company is earning money with second-life Nissan LEAF batteries - Charged EVs*. Charged EVs. <https://chargedevs.com/newswire/this-company-is-earning-money-with-second-life-nissan-leaf-batteries/>

¹⁸⁰ Cornish, C. (2023, November 29). Indian start-up joins race to mine batteries for raw materials. *Financial Times*. <https://www.ft.com/content/9ce88711-6951-40fd-bbe5-aca9c43e15e2>

¹⁸¹ JMK Research. (2024, January 23). *Lithium ion Battery Manufacturers | Battery Recycling Companies India*. JMK Research & Analytics. <https://jmkresearch.com/electric-vehicles-published-reports/recycling-of-lithium-ion-batteries-in-india-1000-million-opportunity/>

investment in local first-stage processing by foreign battery manufacturers seeking raw materials as part of a hub-and-spoke model of recycling¹⁸². Ideally, this would see process stages 1, 2 and 3 from Figure 8-2 taking place in Mongolia, enabling the safe and logistically less complex transportation of the black mass to where stages 4 and 5 can be conducted.

Figure 8-2 Overview of process for EV battery recycling¹⁷⁸



Source: Dr Yu Tack Kim

¹⁸² Sinha, S. J., et al. (2023). *Perspectives of global and domestic companies on advanced chemistry cells battery reuse and recycling*. Page 27 <https://www.niti.gov.in/sites/default/files/2023-07/Battery-book-july-web-version.pdf>

9. Urban Mobility Recommendations

RECOMMENDATION S16: Pilot and Scale-Up Battery Electric Bus Business Model in Ulaanbaatar

- 9.1 This chapter provides a summary of the business model options to enable the wider deployment of BEBs in Ulaanbaatar, which are elaborated in Chapter 11 of this report. Enabling BEB adoption will entail addressing the key contextual challenges of high GHG emissions (broadly at parity with ICE buses) and low vehicle speeds, which result in poor economic performance in the context of capital-intensive technology.
- 9.2 Based on a multi-criteria assessment including economic, strategic and deliverability considerations, it is recommended that BEBs are implemented within dedicated e-bus only corridors of the city, under a business model which features:
- Public bus and battery purchase and leasing agreement, based upon the existing public leasing model recently developed for the EURO V Yutong bus fleet.
 - A 12-year competitive concession contract arrangement for the operation of the fleet, based on route-level planning with economic incentives for operator performance and collaboration on the definition of bus priority measures.
 - Depot and opportunity charging equipped with off-grid renewable energy provided by a third-party Charging-as-a-Service provider, indicatively reducing GHG emissions by 40% compared to purely grid-based charging and ICE buses.
- 9.3 This operating model could:
- Increase operating kilometres by 10% compared to baseline (based on a combination of bus priority and incentives for improved fleet management)
 - Bring lifetime TCO of the BEB fleet to within 2% of an equivalent new EURO V diesel bus, considering the savings in energy over a 12-year period.
 - Indicatively reduce tailpipe GHG emissions by 40% compared to purely grid-based charging and ICE buses using off-grid renewables at depot charging and opportunity charging.

Figure 9-1: An e-bus with on-route opportunity charging in Drammen, Norway¹⁸³



RECOMMENDATION S17: Include E-Mobility Initiatives in Strategic Urban Mobility Planning within an Avoid-Shift-Improve Approach

- 9.4 As detailed in Urban Mobility Readiness, encouraging e-mobility adoption should be reserved for decarbonising residual motorised transport, complementing higher priority policies with objectives of avoiding unnecessary travel and shifting necessary travel towards more sustainable modes. This recommendation uses the Avoid-Shift-Improve framework for thinking about urban mobility improvement and transport decarbonisation, which places the electrification of transport under “improve” (the lowest priority group in the framework).
- 9.5 However, shifting urban mobility towards more sustainable modes can be linked to improvements. For instance, BEBs could contribute to a higher quality public transport system, which in turn could shift personal automobile users to public transport. As such, e-mobility initiatives should be considered as part of broader strategic urban mobility planning packages.
- 9.6 Taking the example of buses, the primary objective should not be to adopt BEBs, but to consider BEBs as a complementary component of a wider package of a sustainable urban mobility package of policies and investments. Indeed, in isolation BEBs, make a relatively weak urban mobility case in terms of encouraging a shift towards public transport. They may attract some users by providing a higher quality of bus than older diesel buses, but if introduced in isolation, they will suffer from the same key issues as diesel buses; slow and unpredictable journey times due to the capital’s severe

¹⁸³ Sustainable Bus. (2020). A batch of 22 Volvo e-buses headed to Drammen, Norway. With 2 articulated models. <https://www.sustainable-bus.com/news/brakar-vy-bus-volvo-electric-buses-drammen-norway/>

congestion issues, an unprofitable business model and a spiral of declining patronage as a result.

9.7 Therefore, it is crucial that BEBs are considered as part of a broader package of urban mobility policies. The package of measures could include:

- Bus sector reform, including:
 - Strong, well-enforced bus priority measures along key corridors
 - Realignment of routes to roads parallel to arterial routes to avoid congestion
 - Improved usage of smart card data
 - BEB adoption along bus priority corridors, supported by RE-powered charging facilities
- Junction improvements & enforcement
- Investment in non-motorised travel infrastructure

9.8 In this scenario, BEBs could play an important role in decarbonising residual transport, aided by the other policies within the package, which would help to enhance their ability to improve urban mobility as well as their ability to decarbonise the sector. Ideally, the scope of the package would be broadened beyond urban mobility to decarbonisation policies in the energy sector, thus further improving BEBs' ability to reduce GHG emissions.

9.9 In order for e-mobility to be considered in policy packages, it needs to be highlighted as a tool for enhancing urban mobility policies in Mongolia and Ulaanbaatar's key strategic documents. Currently, e-mobility adoption is not explicitly mentioned in any of Mongolia or Ulaanbaatar's long-term strategic planning documents, such as the National Vision 2050 document or the Ulaanbaatar 2040 Masterplan. It is only mentioned in the current Government Action Plan (GAP), for 2020-2024.

9.10 Therefore, a key recommendation in the short-term is to update existing long-term strategic planning documents, like the Ulaanbaatar 2040 Masterplan, with a framework for packaging sustainable urban mobility improvements, which assesses the potential of e-mobility within those policy packages. The guidance within these documents should be clear on e-mobility's position in the Avoid-Shift-Improve hierarchy, but also highlight its potential to decarbonise residual motorised transport and improve urban mobility.

9.11 It must be stressed in the guidance of these documents that e-mobility should not be pursued if it is likely to worsen problems of congestion and adversely impact urban

mobility. For instance, allowing electric private automobiles to use bus lanes would likely disrupt bus operation unless the number of electric automobiles were very limited. Beyond the early stages of EV adoption, and even in the short-term, this could decrease the quality and attractiveness of buses and cause an increase in automobile usage.

- 9.12 In the medium- to long-term, this framework should continue to be incorporated into future strategic urban mobility planning documents, whilst being re-evaluated to account for the changing role of e-mobility, as its adoption likely grows into the future. It may be that e-mobility's ability to improve transport systems to the point that it encourages a modal shift will become limited as EVs become more popular, and greater emphasis will have to be placed on ensuring e-mobility is not counter-productive to urban mobility objectives.
- 9.13 These recommendations should ensure that institutions and decision makers consider e-mobility when designing sustainable urban mobility packages in the future, whilst maintaining perspective on its ability to deliver its broader sustainable urban mobility objectives, and being cautious not to implement policies which contradict those objectives.

10. Roadmap implementation

- 10.1 This section offers recommendations on the coordination structures required to deliver the roadmap and for management of e-mobility more broadly in Mongolia, together with a strategic action plan. Its design reflects the cross-sectoral implications to the transport, energy, environment and urban development sectors, among others, and the need to align market development, regulatory and fiscal measures.

Existing Institutional Organisation for E-Mobility

- 10.2 Various public agencies are currently involved in the promotion and management of e-mobility, principally:
- Ministry of Road and Transport Development, which has to date led on analysis and planning for EVs
 - Ministry of Energy and Energy Regulatory Commission which has led on EV charging, investment in RE and other energy-related issues
 - Ministry of Environment and Tourism, which has focused on market development and environmental standards.
- 10.3 At sub-national level, the OGCC and MUB have also led on e-mobility deployment within Ulaanbaatar, including EV charging stations and e-bus implementation.
- 10.4 In June 2023, a Prime Ministerial Decree was approved which mandates the creation of an EV Working Group, chaired by MRTD to
- 1) Study in detail the issues of increasing the use of electric cars and establishing charging centres for electric cars and;
 - 2) Provide management and organisation for presenting, approving, and implementing solutions.
- 10.5 The working group has progressed on the first of these points, and this study will further support that work. During the study, the following coordination challenges have been identified:
- Need for common understanding of the purpose of promoting e-mobility (e.g. GHG, air pollution, energy security) and modality for its implementation (led by consumer demand within an enabling policy and regulatory environment).

- Need for coordination of activities across actors to ensure complementarity and their implementation (e.g. coordination of different public and private EV charging infrastructure initiatives to align coverage with overall need).

10.6 In addition to these strategic level needs for institutional coordination, some of the key barriers faced are specialised in nature and require technical inputs and coordination. These include:

10.7 **EV charging deployment**, which includes:

- Technical/engineering aspects related to implementation of smart charging and implementation of microgrid solutions
- Grid planning aspects, related to planning of EV charger deployment through private operators and alignment with distribution network capacity.
- Business model development, including financial incentives and specifications for public EV charger development
- Economic regulation aspects, including detailed development of an EV charging tariff and development of end user RE markets.

Development of business models for EV deployment in segments assigned for proactive promotion. This includes:

- Developing vehicle and battery leasing models for taxis, light freight vehicle and buses
- Development of pilot programmes for EV deployment with taxi and light freight operators, recognising that while investments will likely be private sector led, institutional coordination will be needed to aggregate demand and develop the legal/institutional delivery framework for vehicle purchase, maintenance provision and charging infrastructure.
- Development of an EV charging-as-a-service industry which includes RE and microgrid solutions.

Market development, with a view to working with the EV industry (principally retailers) to:

- Promote EV uptake and understand the current ecosystem issues and needs
- Promote (or regulate) the appropriate EV technology standards for the Mongolian context
- Promote the correct use of EVs to adapt to winter climate conditions
- Identify routes for battery recycling and reuse and longer-term opportunities for local recycling

Recommendation S18: Establish a Dedicated Structure to Coordinate and Guide E-Mobility Development in Mongolia

- 10.8 In the structure mandated by the Prime Ministerial Decree (see Table 10-1), the Minister of Road and Transport Development chairs the high-level working group on EVs, with the participation of other key government ministries and MUB. This is appropriate at a strategic governance level, with the MRTD well-placed to drive forward the e-mobility agenda with sector-specific collaboration from other ministries and implementation perspectives from MUB.

Table 10-1: E-mobility working group structure from Prime Ministerial Resolution 108 (June 2023)

Role in Working Group	Name	Department	Position
Chairman	S. Byambatsogt	Ministry of Road and Transport Development	Minister
Member	J. Sukhbaatar	National Committee to Reduce Traffic Congestion in the Capital Ulaanbaatar	Head
Member	B. Bat-Erdene	Ministry of Environment and Tourism	Minister
Member	J. Ganbaatar	Ministry of Mining and Heavy Industry	Minister
Member	D. Sumyaabazar	Municipality of Ulaanbaatar	Governor
Member	N. Ankhbayar	Ministry of Foreign Affairs	State Secretary
Member	N. Tavinbeh	Ministry of Energy	State Secretary
Member	B. Dashpurev	Ministry of Economy and Development	Acting Secretary
Member	L. Bayarmandal	Department of Minerals and Oil	Head
Member	B. Gursoronzon	SOE National Motor Transport	Director
Member	Ts. Ariunbold	Transport Police Service	Head
Member	TS. Bayarjargal	National Council of Road Traffic Safety	Head

Proposed roadmap delivery roles

- 10.9 To ensure that agenda-setting and decision-making is aligned with the more detailed technical development of the sector, it will be important to define the technical and executive structure that sits below the overall working group.
- **Programme Management:** The executive coordinating function for the roadmap, reporting to the high-level working group. Responsible for developing and managing the workplan for implementation of the roadmap (in line with the mandate given by the Working Group). It will make recommendations to the Working Group for the ongoing development of e-mobility based on the learnings from projects and technical work packages.
 - **Programme Monitoring, Evaluation and Learning:** Monitoring implementation of the roadmap activities, and real time assessment of how activities and EV deployment are meeting the agreed objectives and indicators (e.g. GHG and air pollution). This will provide data and evidence to feed into long term development of the e-mobility strategy. This function will also provide research on global market and technology developments to understand their suitability and value in the Mongolian context.
 - **Technical Coordination:** This will identify and coordinate cross sectoral task delivery groups with a mandate to develop and implement the recommendations of the roadmap. These should be based on needs and challenges identified during implementation, but in initial stages it is suggested that teams for the following sectors are established:
 - EV Charging Development
 - EV Business Model Development
 - EV Market Development
 - **Implementation Management:** Responsible for planning and coordination of projects and investments related to e-mobility. Given the breadth of the roadmap recommendations, it is recommended that this is disaggregated by policy and regulatory reform (e.g. EV charging tariffs, standards) and EV deployment focused investments (e.g. e-taxi pilots, EV charger implementation).

Proposed institutional arrangement for e-mobility

Figure 10-1: shows the proposed organisation of roadmap implementation, with details and rationale shown in Table 10-2.

Figure 10-1: Proposed organisation of roadmap implementation

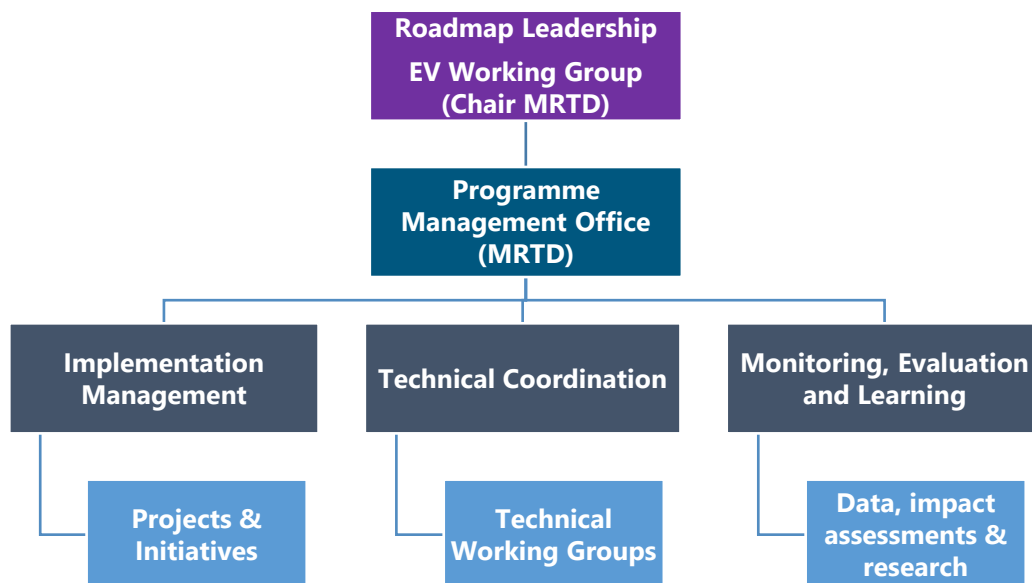


Table 10-2: Proposed institutional roles for e-mobility implementation

Role	Agency	Description and Rationale
Governance		
Roadmap Leadership	EV Working Group (Chair: MRTD)	Existing structure which reports to Prime Minister's Office and includes all major public stakeholders
Management		
Programme Management Office (PMO)	MRTD – Policy & Coordination Dept	PMO should be established as dedicated unit within MRTD. Existing role as chair of WG with executive responsibility for transport and mobility policy in Mongolia.
Technical Coordination	MRTD – Policy & Coordination Department	Coordination of the Technical Working Groups would be part of the overall PMO (within MRTD) structure (e.g. a team within PMO)
Implementation Management	MRTD – Policy and Coordination Department	Management and coordination of EV-related investments and projects would be a function within the PMO (within MRTD). Although the projects and investments may be delivered by other public and private sector implementers (see delivery section below).

Programme Monitoring, Evaluation and Learning (MEL)	MOET – Sustainability and SDGs Division	MOET has responsibility for proposing and monitoring Mongolia's primary policy goals related to e-mobility (GHG and air pollution) nationally and in relation to international commitments (e.g. NDCs). While this function would be led by MOET, there will be a need for strong coordination with MRTD with potential co-location of MEL staff within PMO.
Delivery: Technical Working Groups		
Note: These are indicative and other groups may be necessary throughout the development of the roadmap.		
EV Charging	MRTD (with MOE and MOET)	While there will be a strong energy sector focus in this task group, the objective owner (deployment of suitable EV charging infrastructure) is ultimately the transport sector. This will nevertheless require close engagement with energy stakeholders.
EV Business Models	MRTD & MUB	Given that this is focused on implementation and delivery, it is recommended that this role is shared between MRTD (national level market framework) and MUB (likely to be responsible for most delivery).
EV Market Development	MOET	MOET is closely aligned to the existing EV market actors. As the overall outcome owner (GHG/air quality) it is best placed to sector needs relative to benefits. It is also directly responsible for some of the tasks included in this segment (e.g. battery recycling).
Delivery: Implementation Management		
Policy and Regulatory	MRTD and MOE	Best placed to coordinate the policy and regulatory needs in their respective specialist sectors, which predominantly sit at national government level.
Deployment Projects	MUB	Deployment projects are principally focused upon Ulaanbaatar, and their design and implementation needs, therefore, to align and coordinate with wider sustainable urban mobility goals.

Strategic Action Plan

- 10.10 This section outlines the key actions and timing for the implementation of this roadmap, with recommendations phased into short-, medium-, and long-term actions in Table 10-3 (demand side), and Table 10-4 (supply side) respectively. The action plan also considers those tasks for each of the proposed scenarios; the "Base scenario" (focused on providing an enabling environment for EV adoption) and "Proactive

scenario” (which also encourages EVs through targeted fiscal support to high readiness sectors with a wider policy justification).

- 10.11 The action plan, like the roadmap, is a strategic document to provide the structure and rationale for priority actions to develop and manage e-mobility in Mongolia. Taking this forward will require the active leadership of MRTD and collaboration other stakeholders. In particular, the workplan will need to be developed and evolve over the course of implementation, responding to both technological development and an evolving transport, energy, and urban planning context.

Table 10-3: Demand Side Measures for National EV Strategic Roadmap for Public Transport in Mongolia

ID	Recommendation	Segment	Agency ownership	Institutions involved	Short-term (up to 2030)	Medium-term (2030-2035)	Long-term (beyond 2035)	Enabling	Proactive
D1	Mandate for Citizens to be Able to Request that Public and Commercial Car Parking Spaces be Restricted to EVs/EV Charging Stations Installed	Private Automobiles	MRTD	MUB	Plan, draft & approve legislation/regulation; Partner with private company to develop and launch request tool; promote request tool via EV ecosystem stakeholders		Respond to demand for EV spaces and charging points within the MUB's resources		
		Light Freight							
D2	Right to Install EV Chargers in Communal Residential Parking Lots	Private Automobiles	MRTD	MUB	Plan, draft & approve legislation/regulation		Amend & update if necessary		
D3	E-Bus Only Corridors	Urban Buses	OGCC (Mayor's Office)	MRTD, MUB, PTD	Select suitable corridor; Decide operator(s); Develop route specifications & contracts; Plan & implement strong bus priority	Monitor & evaluate performance of e-bus corridor; Introduce further "Green Corridor" measures	Monitor & evaluate performance of e-bus corridor		

ID	Recommendation	Segment	Agency ownership	Institutions involved	Short-term (up to 2030)	Medium-term (2030-2035)	Long-term (beyond 2035)	Enabling	Proactive
D4	Implement EURO V Fuel Standards	All segments	MRTD, MOET		Plan & approve legislation to meet target of EURO V-only fuel by 2030; Investigate whether supply diversification is necessary; Plan enforcement measures	Implement EURO V minimum fuel requirement; Diversify supply chains if necessary; Enforce & impose fines for non-compliance if necessary			
D5	Support Charging-as-a-Service Models	Light Freight	MRTD	MUB		Using lessons learnt from pilot, encourage expansion of pilot scheme & new providers into the market; Stipulate a requirement for RES generation as part of CaaS	Monitor & evaluate performance of CaaS across segments		
		Urban Buses			Pilot with a single fleet operator, likely a private bus operator				
					Discuss the potential for CaaS with formal taxi companies & ride-hailing companies while taxi sector is formalised				
		Taxis			As taxi sector formalises, encourage CaaS to incentivise EV adoption				
D6	Encouraging Banks to Finance EVs	Private Automobiles	MRTD	Ministry of Finance	Provide guarantees to FIs, longer term loans & greater amounts				

ID	Recommendation	Segment	Agency ownership	Institutions involved	Short-term (up to 2030)	Medium-term (2030-2035)	Long-term (beyond 2035)	Enabling	Proactive
		Light Freight							
D7	EV Charger Subsidy	Private Automobiles	MRTD	MUB MOET	Plan & approve funding for subsidy; Use tools for grid mapping & EV charger demand requests to identify target areas (see D1)	Target subsidy funding at segments and areas with the biggest gap in charger supply	Gradually reduce subsidy provision as the charging network becomes more developed & EVs/infrastructure becomes more commercially viable		
		Light Freight							
		Urban Buses							
D8	EV-Only Restriction at EV Charging Spaces	Private Automobiles	MRTD	MUB, Police	Plan, draft & approve regulations; Coordinate with USUTP Smart Parking Management System; Develop parking enforcement arm of traffic police; Develop and approve standard signage & markings to denote EV-only restriction	Review the ability of parking restriction enforcement to self-fund; Update enforcements as required & expand with charging infrastructure; Provide dedicated parking stations for taxis, which would then not be able to charge as public stations			
		Light Freight							
		Taxis							

ID	Recommendation	Segment	Agency ownership	Institutions involved	Short-term (up to 2030)	Medium-term (2030-2035)	Long-term (beyond 2035)	Enabling	Proactive
D9	Reduced-Fee Parking for EVs	Private Automobiles Light Freight	MUB	MUB, Police	Coordinate with USUTP Smart Parking Management System; Plan & introduce technology & pricing structure for reduced fees for EVs	Gradually reduce/remove the EV discount rate as EVs become more popular and more vehicles become eligible for this incentive			
D10	Alignment of Taxation on private EVs with ICEVs	Private Automobiles	MRTD	GoM, Ministry of Finance, Ministry of Industry and Trade	Develop financial analysis and proposed adjustment to equalise nominal tax on EVs to those of ICEVs; request adjustment from taxi authorities	Review tax rates over time as the relative cost of EVs to ICEVs falls to maintain parity.			
D11	Develop Leasing Business Model for EVs	Light Freight Urban Buses Taxis	MUB	MOET	Implement pilot leasing programmes for urban freight (private) and e-buses (public)	Expand e-bus programme Promote expansion of urban freight electrification and implement e-taxi pilot.			

ID	Recommendation	Segment	Agency ownership	Institutions involved	Short-term (up to 2030)	Medium-term (2030-2035)	Long-term (beyond 2035)	Enabling	Proactive
D12	Develop Battery Leasing Mechanisms	All segments	MRTD	MUB, MOET	Engage with EV distributors to develop private sector battery leasing schemes; Identify battery waste management arrangements;	Introduce battery leasing applications as part of pilot and scale up.			
D13	Reduced Licensing Fees for Taxi Operators	Taxis	MUB	PTD	Incorporate EV license discount into taxi sector formalisation plans including economic analysis.	Pilot EV license discount into e-taxi pilot, assess impact, and if appropriate scale up as the taxi segment formalisation is rolled out.	Monitor ongoing effectiveness of EV license fee reduction over time.		

Table 10-4: Supply Side Measures for National EV Strategic Roadmap for Public Transport in Mongolia

ID	Recommendation	Components	Agency ownership	Institutions involved	Short-term (up to 2030)	Medium-term (2030-2035)	Long-term (beyond 2035)	Enabling	Proactive
S1	Promoting Cold-Weather EV Performance Optimisation Practices by EV Owners and Users	EV pre-heating before driving	MOET	MUB, PTD, MRTD	Educate & encourage drivers to pre-heat their batteries; Encourage the use of block heaters to pre-heat batteries; Ensure public transport fleets use pre-heating as a standard practice				
		Educate & encourage drivers to use slow-charging where possible; Ensure public transport fleets use slow charging as a standard practice for overnight charging							
		Educate & encourage drivers to purchase vehicles with smart charging features							

ID	Recommendation	Components	Agency ownership	Institutions involved	Short-term (up to 2030)	Medium-term (2030-2035)	Long-term (beyond 2035)	Enabling	Proactive
S2	Encourage Importation of EVs with Heat Pumps		MOET	MRTD	Work with distributors to import vehicles with heat pumps; Educate & encourage drivers to purchase vehicles with heat pumps installed				
S3	Ingress Protection (IP)/Impact Protection (IK) for EV Charging Infrastructure		MRTD	MOET	Implement IP 65 and IK 10 or higher requirement for EV chargers; Consider requirement for NEMA certification				
S4	Update EV charging stations standards & safety requirements	Inclusion of additional/remaining parts of IEC 62196	MRTD	Mongolia Standards Agency	Incorporate Parts 4 & 6 of the standard (relating to digital communication between chargers and EVs, and hazardous environments)				
		Introduce this standard to increase compatibility of EVs with chargers							
		Incorporate Chinese standards into existing charger standards							
		Introduce IEC 62752 (in-cable control & mode 2 charging protection) and IEC 62955 (residual direct current (RDC) detecting devices) into charging standards							

ID	Recommendation	Components	Agency ownership	Institutions involved	Short-term (up to 2030)	Medium-term (2030-2035)	Long-term (beyond 2035)	Enabling	Proactive
S5	Promote Smart Charging to Minimise EV Charging Impact During Peak Demand Hours		MRTD	MUB; MOET; Mongolia Standards Agency	Ensure public chargers are equipped with smart charging technology; Hardware and communication standards for charge point operators & suppliers;	Support in setting up demand response and grid services markets; Support in setting up EV and charging subsidies, standards; Support in setting up time of use or grid demand-based tariff structures	Introduce requirement for smart meters at households; Introduce smart charging requirement for public chargers into standards; Financial incentives for vehicle to grid EVs; Incorporate bi-directional capabilities into the grid code		
S6	Promote and Incentivise Microgrid Solutions with RES to Reduce Grid Impacts and Carbon Intensity of EV Charging		MOE	MRTD; MUB	Work with charging station operators and PT fleet operators to implement mini-grid systems with RES				
S7	Strengthen EV Charger Planning and Implementation in Partnership with Private Sector Stakeholders				Develop public EV charging implementation model and strategy	AC level 2 charger supporting OpenADR or OSCP as a standard	AC level 2 charger supporting vehicle to grid		

ID	Recommendation	Components	Agency ownership	Institutions involved	Short-term (up to 2030)	Medium-term (2030-2035)	Long-term (beyond 2035)	Enabling	Proactive
S8	Establish Coordination Mechanisms Between Grid Actors and EV Charging Point Operators		ERC	UBEDN, MUB	Develop and implement open planning tool identifying potential EV charging points aligned with grid capacity, demands and other metrics.				
S9	Implement EV Charging Tariffs		ERC	UBEDN, NDC, MOE	Develop tariff regulation for EV charging tariffs, responsibilities and implementation mechanism	Review and optimise tariffs to support objectives (demand shift, economic support of EV sector).			
S10	Create End-User Market in Renewable Energy through the Grid	Enable open trading of RE between generators and certain consumers	MOE	ERC, NDC, UBEDN	Amend the current regulatory framework to allow RE developers to sell power directly also in the market (i.e. to end users/ consumers - e.g. EV charging station operators with high load requirements)				
		Introduce Renewable Purchase Obligation (RPO) targets for Discoms and high-consumption industries/users	MOE	ERC, NDC, UBEDN		Agree and implement RPOs to users operating in open market to create RES market.	Review and adjust RPO to support RES market development		

ID	Recommendation	Components	Agency ownership	Institutions involved	Short-term (up to 2030)	Medium-term (2030-2035)	Long-term (beyond 2035)	Enabling	Proactive
S11	Strengthen Investment Climate for RES Development to Enable Wider Grid Decarbonisation	Improve access to financing and reduce payment risks for developers	MOE	ERC, NDC	Improve the reliability of payment of FIT to developers.	Measures to boost domestic financing for RE projects by providing long tenure loans at lower interest rates; Establish a dedicated RE agency responsible for monitoring and managing issues encountered by developers			
		Government to phase-out Subsidies to Fossil Fuel Generator	MOE	Ministry of Finance, ERC, NDC, MOET	Conduct social and economic impact assessment on removal of coal subsidies; seek approval for subsidy removal and distribution to energy sector	Monitor economic and supply related dynamics of level playing field for energy generation.			
		Lower RE Capex Cost	ERC, NDC	MOET	Work with private developers to explore solutions to high RE capex cost (e.g. reviewing tax structures and revising FiTs periodically to align with early-stage RE development and evolving system costs)				
S12	Pilot Roll-Out of Captive RE Integration for Public Transport E-Buses		MUB	UBEDN	Plan & implement pilot of RE integration with e-bus charging infrastructure, possibly through a CaaS provider				

ID	Recommendation	Components	Agency ownership	Institutions involved	Short-term (up to 2030)	Medium-term (2030-2035)	Long-term (beyond 2035)	Enabling	Proactive
S13	Incorporate E-Mobility Targets into Environmental Target-Setting and Policymaking		MOET	MRTD, MUB	Incorporation GHG and other air pollution targets related to e-mobility into roadmap implementation and monitoring plan; monitor impacts. Include the decarbonisation impacts of its e-mobility ambitions into future NDC updates				
S14	Encourage Second Life Uses for Used EV Batteries		MOET	MRTD, MUB	Work with EV manufacturers to identify opportunities for second life uses.	Negotiation of regulations on export of EV batteries to recycling facilities in neighbouring countries			
S15	Develop EV Recycling Pathways, Potentially Using a Hub and Spoke Model		MOET	MRTD, MUB	Work with EV distributors in Mongolia to develop the process of collection and export and develop the financial mechanisms for exporting EV batteries		Explore investments in local first-stage battery processing (potentially as part of a hub-and-spoke model)		
S16	Pilot and scale up BEB business model		MUB	MRTD, Ministry of Finance	Validate and further develop proposed PPP e-bus model; develop e-bus corridor proposal; implement pilot in consultation with operators	Monitor economic and operating performance of pilot; if appropriate, expand application			

ID	Recommendation	Components	Agency ownership	Institutions involved	Short-term (up to 2030)	Medium-term (2030-2035)	Long-term (beyond 2035)	Enabling	Proactive
S17	Include E-Mobility Initiatives in Strategic Urban Mobility Planning within an Avoid-Shift-Improve Approach		MUB	PTD	Develop e-mobility proposals within strategic transport plan for UB and test benefits relative to other options (e.g. mode shift); Re-align e-mobility roadmap with strategic mobility plan as needed.	Monitor changes in the potential of e-mobility as a decarbonisation tool in response to changes to the urban mobility and energy context in Ulaanbaatar			
S18	Establish a Dedicated Structure to Coordinate and Guide E-Mobility Development in Mongolia		MRTD	MOET, MUB	PMO set up to oversee the technical coordination, implementation management & MEL of the e-mobility roadmap. Technical working groups set up for delivery specific to sectors.	Periodically evaluate the effectiveness of the institutional structure and make adjustments if required.			

Section 3

E-Bus Business Models



a company of Royal HaskoningDHV

11. E-Bus Business Model Review

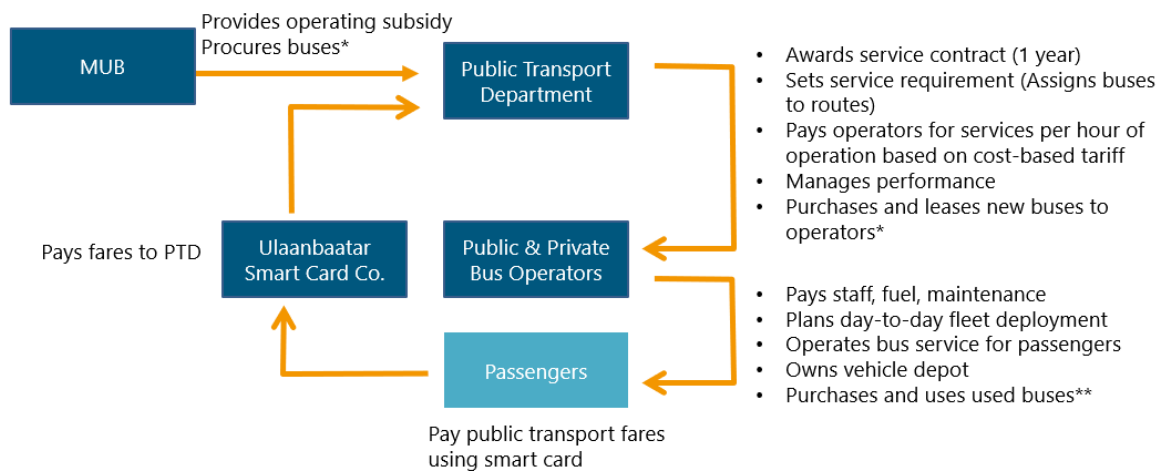
- 11.1 Transition of urban buses to EVs is an important step in the decarbonisation of urban mobility, however their deployment implies major changes to financing, funding and operating models for operators and public transport agencies. Ulaanbaatar has experience in piloting BEBs through public sector operators and has demonstrated the suitability of the technology in the local context. This section provides guidance and recommendations to strengthen the investment and operating business model to enable BEBs to be deployed in an optimised way through public and private sector operators.
- 11.2 In line with the vehicle segment recommendations, these recommendations are designed to support e-bus deployment in a context of off-grid renewable energy charging, and as part of a programme of performance enhancements (i.e. bus priority).

Institutional Assessment of Current Business Model

- 11.3 This assessment seeks to capture the existing urban bus business model, which currently applies to all vehicle fuel technologies.

Urban buses in Ulaanbaatar currently sit within a framework of mixed public and private investment and operations. Figure 11-1 provides an outline of the urban bus business model, including both capital investment and operational aspects. Essentially, the MUB PTD is the overall system manager. It contracts bus services through public and private sector operating companies, which provide services under a gross cost (per hour) contract arrangement. There are two fleet capital investment models, with a public leasing model (until recently principally for public operators) and private operator investment model (the future of which is unclear).

Figure 11-1 Current bus operating framework



* New buses have typically been leased only to public operators, however since 2024 also to private operators

** Used buses were previously the standard investment model for private operators, however this may have been superseded by the recent public leasing programme.

Key stakeholders

Municipality of Ulaanbaatar / Office of the Governor of the Capital City

11.4 MUB, through the Office of the Governor of the Capital City (OGCC), is responsible for setting overall transport direction in Ulaanbaatar (including policymaking and priority setting), and providing resources for both capital investment and operating subsidy. This includes overall support for a transition to sustainable urban mobility, and recent drive for expansion of bus services and bus fleet modernisation. MUB was responsible for coordination of the recent fleet of 507 new EURO V buses, supported by technical inputs from MUB PTD and procurement/operator leasing through the publicly owned Ulaanbaatar Development Corporation.

11.5 As a **system owner**, its priorities include:

- Improvement in overall urban mobility in the city across modes, including shift to sustainable mobility and reductions in congestion
- Ensuring overall performance and value-for-money from the bus network

Public Transport Department (PTD)

11.6 MUB's Public Transport Department (MUB PTD) is responsible for planning and management of the public transport network including route planning, fleet specification, service contracting and operational management and development of the network. This includes:

- Service planning, assignment of operators and vehicles to routes
- Performance management and payment of operators, including negotiation of the agreed tariff structure based on operator costs.

11.7 As **system manager**, its priorities include:

- Effective performance management of operators
- Achieving value for money in public transport provision

Bus Operators

11.8 Operation of Ulaanbaatar's bus network is provided by 18 bus companies (16 private and 2 public), with an approximate market share of 70% and 30% respectively. Table 11-1 below shows the list of bus operators and fleet size as of October 2022, which is still broadly representative of the bus operator market in Ulaanbaatar at the time of writing.

Table 11-1: Bus operator market structure

#	Company	Buses scheduled on the route daily	Percentage %
1	BUS operator 1 SOE	119	12.2
2	BUS operator 2 SOE ¹⁸⁴	99	10.1
3	BUS operator 3 SOE	74	7.6
4	Erdem Trans LLC	167	17.1
5	Tenuun Ogoo LLC	90	9.2
6	Auto terminal trade LLC	45	4.6
7	Bus integration LLC	21	2.1
8	GBUS LLC	10	1.0
9	DYUTS LLC	19	1.9
10	Myralzaa LLC	34	3.5
11	Saikhhan Ireedui LLC	17	1.7
12	Sutain Buyant LLC	66	6.8
13	Transbus LLC	86	8.8

¹⁸⁴ Fleet part of Bus Operator 1

#	Company	Buses scheduled on the route daily	Percentage %
14	Tenuun Ogoo - 3 LLC	36	3.7
15	Bluebus LLC	35	3.6
16	EMSID LLC	34	3.5
17	S&I LLC	15	1.5
18	Unegtiin Uul LLC	7	0.7
19	Buural Myangan LLC	3	0.3
	Total fleet size	977	

Private operators

- 11.9 Private bus operators are relatively small by international context, ranging size from 15 to 150 buses in their fleet. The largest operators are Erdem Trans (167 buses), Transbus (86 buses) and Tenuun Ogoo (74 buses), with most of the remainder of the fleet smaller, often family-owned operations (although sometimes part of larger business holdings). The operators are organised into two operator associations which advocate for their members to MUB PTD, including the contract rates (based on agreed cost structures).
- 11.10 Private operators all have some degree of technical and financial capabilities in fleet procurement, operations and maintenance, including their own depots. Nevertheless, the relatively small size of most operators limits their financing capacity and risk appetite and their capital investment is limited to used bus imports. No private operator has experience in e-bus investment or operation.

Public operators

- 11.11 The two public bus operators are organised by the Public Transport Department, with buses operating from Bus Park 1 and Bus Park 2 are controlled by one public operator, and buses from Bus Park 3 are controlled by another. Fleet is typically procured and leased to them through MUB. Public operators provide services under the same operating contract as private operators. Public operators do have experience of electric vehicle operation and maintenance, including trolleybuses (vehicles and infrastructure) and battery electric buses (pilot deployments).

Capital investment approaches

Public leasing model

- 11.12 The public sector leasing model has traditionally been the model for procurement and assignment of vehicles to the public sector operator. However, as of 2024 this model has been extended to private operators, enabling them to integrate the new EURO V 12m diesel buses into their fleet.
- 11.13 The lessor for the vehicles is the Ulaanbaatar Development Corporation (UBDC), an arms-length company owned by MUB for the implementation of PPPs. The vehicles were financed through municipal revenues. The terms of the leases to operators were set at:
- A collateral guarantee equivalent to 5% of the new asset value of the vehicles
 - Payment of the vehicle capital cost (US\$80,000) in monthly payments over 7 years (84 months).
 - Payment by the lessee of an annual service fee equivalent to 3% of the total new value of the vehicle (equivalent to approximately 5.5% annualised interest payments on a commercial loan).
 - Following the completion of the seven-year payments, the vehicle would transfer to the ownership of the private operators.
- 11.14 Operators were required to apply for the leases to UBDC, and the scheme was oversubscribed. Engagement with bus operator sources indicated that the scheme was viewed positively by operators.

Private investment model

- 11.15 Private operators have traditionally procured, owned and maintained their own fleets, with each operator providing their own depot facilities. Fleet procurement decisions have been made by private operators, within the fleet type (e.g. 12m) and age (maximum 12 years) specifications in the service contract with MUB PTD.
- 11.16 The investment model for this has been the purchase of used vehicles (usually eight-year-old buses from South Korea), which allows for four years of service in Ulaanbaatar¹⁸⁵. Key financial metrics include:
- Capital cost in range of US\$15,000 - \$18,000

¹⁸⁵ The 12-year limit was temporarily extended by City Council resolution to mitigate the impact of the COVID-19 pandemic on operator finances

- Service life of 3-4 years
 - Financing through local commercial banks in MNT over 3 years. Current interest rate of 18% (considering local base rate is 13% in MN).
 - There are increasingly more Chinese used buses available
- 11.17 Operators reported having previously investigated purchase of new ICE buses however key challenges included:
- High local interest rates (local financing) and currency risk premiums (in foreign currency financing)
 - High risk premiums for operators considering the short operating contracts.
- 11.18 Past explorations with e-buses, had found that combination of the above factors (and considering the higher capital cost) made e-buses unfeasible financially (9% interest rates in USD), and in terms of the risk associated with financial leverage and currency risk requirements.

Operations approach

Key features of operating contract

- 11.19 Both public and private bus operators provide services under the same gross cost service contract. These contracts are issued for one-year periods (the maximum permitted under Mongolian public procurement laws), with contracts issued by MUB PTD to operators for a specified number of buses to be made available to the system manager. These are then assigned to routes and services by MUB PTD.
- 11.20 Operators are remunerated under these contracts on the basis of service hours. While international best practice typically uses service kilometres as a more relevant performance-based metric, the use of service hours in Ulaanbaatar may reflect the impact of congestion and mixed-traffic operation as a factor outside of the control of individual operators.
- 11.21 Hourly payment rates are set by MUB PTD in negotiation with operator associations on the basis of an approved cost structure which varies between vehicle category but is uniform across operators. The rate is adjusted periodically (e.g. in the case of major changes in cost structure such as fuel price increases), with rates proposed by MUB PTD then requiring approval by the City Council. Table 11-2 shows the total operator rates effective as of the time of this study, with an example breakdown of the cost structure across key vehicle types shown in Table 11-3.

Table 11-2: Hourly bus operator payments as of March 2024

Bus type	Detail	Tariff, MNT	Tariff, USD
Articulated bus	All	84,471	24.62
Large bus (used, diesel)	Purchased used	68,947	20.10
Large bus (new, diesel)	Purchased new	80,807	23.56
Large bus (CNG)	All	68,695	20.02
Large bus (electric)	All	70,417	20.02
Double decker bus (electric)	All	80,564	23.48
Trolleybus	All	55,588	16.20

Table 11-3: Breakdown of hourly bus tariffs (to March 2024)

	Large bus (used)		Large bus (new)		Large bus (electric)	
Unit	MNT	USD	MNT	USD	MNT	USD
Fuel	23,800	6.90	25,754	7.46	2,301	0.67
Oil (Lubricants)	604	0.18	604	0.18	604	0.18
Spare parts	4,873	1.41	4,873	1.41	4,873	1.41
Salary	14,306	4.15	14,306	4.15	14,306	4.15
Social insurance fee	2,074	0.60	2,074	0.60	2,074	0.60
Amortisation	1,774	0.51	7,385	2.14	19,634	5.69
Others	3,622	1.05	3,622	1.05	3,622	1.05
Ticket checker	2,311	0.67	2,311	0.67	2,311	0.67
Total	53,364	15.47	60,929	17.66	49,725	14.41

Table 11-4: Breakdown of bus operator tariff structure as of May 2024

	Large bus (used)		Large bus (new)		Large bus (electric)	
Unit	MNT	USD	MNT	USD	MNT	USD
Fuel	10,141	2.96	23,800	6.94	7,410	2.16
Oil	240	0.07	604	0.18	604	0.18
Spare parts	2,377	0.69	4,873	1.42	4,873	1.42
Salary	32,864	9.58	29,934	8.73	29,934	8.73
Social insurance fee	4,765	1.39	4,340	1.27	4,340	1.27
Amortisation	3,998	1.17	1,774	0.52	19,634	5.72
Others	2,203	0.64	3,622	1.06	3,622	1.06
Total	56,588	16.50	68,947	20.10	70,417	20.53

11.22 The breakdown of tariff by category shows some of the key variables in the operating cost structure, particularly focused on fuel consumption differences (by fuel technologies) and amortisation (by capital cost implications of old/new/electric buses). This does provide a mechanism for the public sector to capture both the increased investment costs of e-buses and to recoup the benefits in the form of reduced fuel/energy consumption. However:

- The uniform negotiated tariff for bus operators (rather than competition-based contracting) hinders the ability of MUB PTD to drive cost efficiencies in its procurement of bus services.
- Cost recovery approach to payment creates a situation in which bus operators are not incentivised to maximise deployment of the most cost-efficient fleet (i.e. e-buses, which have the lowest marginal operating cost)
- The capital investment of charging infrastructure (and associated renewable energy generation) is recovered over the fleet lifecycle (typically 12 years) which does not align with the current one-year service contract. This creates practical risks and legal uncertainty when considering depot-based charging infrastructure.

Key Considerations for E-Bus Business Model Development

11.23 The shift from operations of ICE buses to BEBs will require:

- A shift in planning model from vehicle (fleet) level planning to system level planning in which buses, charging infrastructure and energy supply are aligned, together with route and service planning.
- Consideration of how to accommodate the different financial profiling of e-bus, battery and charging investment (and financing) requirements and operational costs.

11.24 In the context of Ulaanbaatar, implementation of e-buses through private operators will require a business model which is financially and economically viable to the operator and MUB, compatible with the current public transport contracting and governance framework, and which aligns public and private incentives for efficient deployment of capital-intensive e-buses.

Table 11-5 below provides an assessment of the opportunities and challenges in the current public transport investment and operation model, as they are relevant to e-buses.

Table 11-5: Opportunities and challenges for e-bus operating in Ulaanbaatar

Component	Entry Points	Challenges
Capital – Bus and Battery	• Public bus leasing scheme exists and well received • Public sector experience in e-bus procurement • Private operators have experience in investment	• Short operating contracts limit private investment potential • High interest rates in MNT and volatile exchange rate • Limited financial capacity of private operators
Capital – Charging Infrastructure	• Public sector experience in charging infrastructure (not RES) • Private sector market for renewable energy	• Short service contracts make investment in depot-based charging risky • Energy grid connection a bottleneck • No retail market in renewable energy – off-grid required
Operations	• Relatively professional bus operations sector • Opportunity to improve performance and productivity through bus priority	• Weak incentives for operator efficiency, performance or fleet capital productivity • No single 'system' approach to planning

Business Model Options

- 11.25 As outlined above, the introduction of e-buses involves (relative to ICE buses) a higher upfront cost, additional risk profile (actual and perceived technology risk) and different institutional arrangement. Different procurement, financing and ownership models exist which respond to these, enabling operators and transport authorities to mitigate and balance these different factors. As summarised in Table 11-6 below, each basic component of e-bus investment (the bus, the battery and the charger) can be financed and owned either by the public sector (e.g. MUB), the private operator, or by a specialist third party as a leasing company or service provider (e.g. Battery as a Service, Charging as a Service).
- 11.26 These offer the ability to reduce the upfront financing requirements associated with e-bus investment, to apportion the risks associated with the system to the party best able to manage it (for example batteries and energy infrastructure, which are not typically areas of technical competence for bus operators). Managing the risks and public financing requirements does typically however increase the overall long term funding requirement due to higher private financing rate.

Table 11-6: Options for e-bus investment

	Public (MUB) Led	Bus Operator Led	Private Sector 3 rd Party Led
Bus 	Public procurement Leased to operator	Operator procurement and ownership	Vehicles leased by third party to government or operator
Battery 	Public sector procurement and periodic replacement. Leased to operator	Operator procurement and periodic replacement	Private (e.g. OEM) battery leasing Leased to operator
Charger 	Public sector procurement and installation. Leased to operator	Operator procurement, installation and operation.	Private sector procurement, installation and operation (Charging as a Service).
Typical Public Sector Roles / Responsibilities	Procurement and financing of assets Technology risk owner	Guarantees to enable access to financing Typically, higher TCO to cover through operating contract	Long term guarantees to lessors Typically, higher TCO to cover through operating contract

Higher govt involvement

Lower TCO (financing cost)

Fewer Private Sector Incentives

➔

Lower govt involvement

Higher Financing Cost

More Private Sector Incentives

Vehicle and battery

11.27 Table 11-7 below outlines the options for capital investment in the bus and battery¹⁸⁶, considering the existing relevant experience in Mongolia, opportunities, challenges and overall consideration of its deliverability.

Table 11-7 Opportunities assessment for vehicle and battery models

Option	Experience in Mongolia	Opportunity	Challenges	Conclusion
Public Leasing	Public bus leasing scheme as recently implemented for EURO V Yutong buses	Established model and popular with operators Lowest financing cost	High capital intensity Public procurement typically has less scope for innovation	Deliverable, subject to availability of financing

¹⁸⁶ While in some cases different financing arrangements may be used to finance buses and batteries on any given scheme, the models are conceptually very similar and are therefore included here as one for simplicity.

Option	Experience in Mongolia	Opportunity	Challenges	Conclusion
Private purchase	Private purchase of used vehicles by operators as previous practice.	Provides incentives for innovation and life-cycle costing	Operators unable to finance without extensive guarantees (financing, currency, long-term operation) ¹⁸⁷ High interest rates No experience in e-bus operation and limited experience of investment of this size May involve legal/institutional reform to allow guarantees.	Extent of public guarantees means unlikely benefits (innovation) outweighs costs (guarantees and underwriting of risks)
Third party leasing (bus)	No relevant experience in Mongolia	Removes financing requirement Reduces technology risk (at a cost)	Typically high service cost (likely also forex risk)	Deliverable, but unclear if benefits outweigh increase costs (vehicle are high costs and relatively low risk)
Third party leasing (Battery)	No relevant experience in Mongolia	Reduces long-term technology risk (i.e. battery performance) Reduces financing requirement Often offered by OEM	Service cost higher than public financing (and likely in foreign currency)	Deliverable, however risks and benefits need to be carefully considered

¹⁸⁷ Operators proven financing ability per vehicle is around US\$20,000, with new e-buses proximately ten times this value even if battery were leased separately.

Key findings:

- In Mongolia, the public bus leasing model would work for the vehicles and batteries, whilst being institutionally the most straightforward and having existing precedent in the country.
- Private operator investment in vehicles is not feasible or advantageous in the current bus operator market and institutional structure. The extent of public sector guarantees required would not transfer any risks or incentives, and it is unclear if private operators would be better placed to make better procurement decisions.
- A combination of private and/or third-party investment may be feasible if contracts were moved to a concession arrangement (i.e. long-term contracts awarded by competitive tender), however this would likely require external financing and partnership (e.g. through a third party leasing company or international public transport operator investment).

Charging infrastructure

- 11.28 The recommendations of this study are for the implementation of e-buses only in situations where green energy can be used to mitigate carbon emissions. Considering that there is no end-user market for renewable energy in the Mongolian energy regulatory framework, in the current context this would require that e-bus charging infrastructure is accompanied by off-grid renewables energy generation (typically solar).
- 11.29 The specific e-bus charging strategy would be developed based on technical studies developed on a route-by-route basis, although typically consists of overnight depot charging with the potential for opportunity charging to ensure vehicle range¹⁸⁸. From a business model perspective, the addition of RE generation presents the following interlinked issues and questions:
- Which party invests in the infrastructure?
 - Which party provides the land/location over the asset lifecycle?
 - Which party provides the economic guarantee (over a lifecycle of typically 25 years)?

¹⁸⁸ As reported during the first mission, e-buses in Ulaanbaatar require one additional charge during summer, and two during winter. In this context, on-route opportunity charging would support operational productivity.

Overnight depot charging with green energy

- 11.30 Table 11-8 below shows the feasible options for investment, location and financial guarantees related to depot based RE provision and associated overnight charging infrastructure. While investment models exist in Mongolia for this to be delivered either through private energy providers or public investment, the key challenge here is the misalignment in timescales between the required financial guarantees (20-25 years) and bus operating contract (1 year). This would provide unacceptable levels of risk upon the public sector, which would be required to provide economic guarantees and would have limited levers to manage performance given this sunk cost. It is also unclear if the 1-year contract would be sufficient to incentivise operators to provide the space/land for RE infrastructure (although potentially so in the event of a longer vehicle lease contract e.g. 12 years).
- 11.31 Options to address this include:
- Operating models with longer contractual certainty and/or stronger performance incentives
 - Contractual options for energy to be sold to the grid through the Feed in Tariff in the event that it is not used for e-bus charging
- 11.32 Either of these options (or both) would reduce the economic risks associated with economic guarantees provided by the public sector, and even potentially allowing them to be provided by the private operators.

Table 11-8: Proposed depot charging model

Role	Responsible Party & Rationale
Delivery	Public or private energy firms with greater RE expertise in private sector.
Land	Depots are all currently owned by operators
Economic Guarantees	Public sector. Operators are not able to provide long term demand guarantees based on current (annual) contract. In other operating models (e.g. concession systems) this may be more feasible.

Opportunity charging with green energy

- 11.33 Table 11-9 below shows the options for opportunity charging infrastructure models, in which renewable energy and charging infrastructure is provided outside of operator facilities. Similar to the depot charging options, public or private delivery models can

be considered, with locations for chargers determined by public sector (e.g. MUB PTD) based on service planning needs (e.g. at or close to key bus termini/stops).

- 11.34 This model would not be susceptible to the same risk of chargers 'captive' to a particular private fleet operator site (i.e. specific operators depot) and would therefore ensure their continued use as long as e-buses remain in the fleet for a particular route. Since this is a decision within the control of MUB PTD, the risk is mitigated.

Table 11-9: Proposed opportunity charging model

	Notes
Delivery	Public or private energy firms. More RE expertise in private sector.
Land	Locations would be specified in alignment with MUB PTD service planning and charging strategy.
Economic Guarantees	Public. Operators are not able to provide long term demand guarantees based on current contract. It may be desirable for multiple operator use on certain routes. In other operating models (e.g. concession systems) operator guarantees may be more feasible.

Charging infrastructure without captive green energy

Captive renewable energy is currently necessary for low carbon e-bus implementation in alignment with the recommendations of this study. However, in the event of future energy regulation reform to create an end-user market for renewable energy, it will no longer be necessary for on-site generation (with RE purchase through the grid). This will have the following implications:

- Capital investment greatly reduced for both overnight and opportunity
- Reduction in lifecycle duration for e-bus charging. While the current service contract duration makes it unlikely that operators would invest in infrastructure (or provide long term guarantees to private providers), removal of the need for off-grid RE generation can enable a viable business model since it will:
 - Mitigate public sector risk of providing this infrastructure through packing charging infrastructure within a vehicle leasing program.
 - Reduce the legal barriers (land, regulation) to accepting e-buses due to lower space requirement, technical complexities, and shorter lifespans.

Recommendations

11.35 The recommended options for charging infrastructure are shown in Table 11-10 below, the key factors in which include:

- Delivery of overnight charging using green energy is only currently deliverable with longer bus operating contracts which align the financial and legal risks with long-term demand guarantees and performance. Without long term contract reform, longer term vehicle leases and performance-based contracting based on development of a specific route may be acceptable.
- Opportunity charging using green energy should be led by the public sector (e.g. MUB PTD) to allow multiple operator use, with preference for procurement through private sector RES or Charging as a Service providers.
- It is recommended to use private investment for e-bus charging models which involve renewable generation, enabling harnessing of global learning and expertise in optimisation and efficiency of such systems. E-bus chargers without RES could be delivered by the public sector however it would be important for collaboration between operators and MUB PTD on service planning and charging strategy.

Table 11-10: E-bus charging models

	Delivery	Location	Economic Guarantee
Overnight charging (green energy generation)	Private Leasing (Charging Service)	Operator (Long Term Contract or Potentially Aligned with Long Term Bus Lease)	Operator & Public
Overnight charging (grid energy)	Private Leasing (Charging Service)	Operator (Aligned with e-Bus Lease)	Operator & Public
Opportunity charging (green energy generation)	Private Leasing (Charging Service)	Public or Private (aligned with Public service planning)	Public

Operation

- 11.36 The assumption is for the integration of e-buses into the current public transport operations model (i.e. based upon a form of gross cost contract with payment based on service provision rather than user fares).
- 11.37 There are various challenges with this as it relates to e-buses, including; Access to private vehicle financing; Risk associated with depot-based charging infrastructure; Limited incentives to maximise resource intensity of use. In considering the operating model, the following options are considered.

Existing Contract

- 11.38 As described above, the current contract is a one-year gross cost contract based on hourly payments for operation. This rewards the operator for fleet deployment, but not for fleet productivity (either in passengers or service kilometres) despite the operator being responsible for detailed service planning and management. This is a key aspect of the financial challenges facing the existing bus system. Given the higher capital cost of e-buses compared to ICE buses (three times greater), this effect would be intensified in the event that e-buses were deployed using this model.

Enhanced Partnership Contract

- 11.39 The introduction of more modern vehicles and bus priority infrastructure/technology measures on corridors will benefit operators through increasing fleet productivity and encouraging mode shift/increase demand. Based on feedback with existing operators,

more modern vehicles and e-bus technology will also improve image and support advertising revenues. As an incremental improvement, MUB PTD could negotiate improvements to the contract to promote and incentivise performance. This could include:

- Contracts based on service kms (rather than hours) to incentivise productivity improvements
- Collaboration in the design and implementation of bus priority measures and contractual bonuses for performance enhancements
- Revenue sharing on advertising and ancillary revenue

Concession Contract

11.40 Subject to the Mongolian PPP framework, a more ambitious option may look like a long-term concession contract in which operators bid for long term (5-10 years is common) operating contracts based on delivery of a certain number of kilometres and performance. This would additionally introduce:

- Financial and technical competition through a competitive bidding process (rather than a negotiated cost-based contract), encouraging innovation and efficiencies while rewarding ongoing performance.
- Contractual certainty to enable private sector capital investment (for example in buses, batteries, chargers) and also de-risking depot-based charging infrastructure.

Table 11-11: Summary of contract options

Option	Description	Opportunities	Challenges
Existing Contract FLEET BASED	One year cost-based contract	Institutionally simplest option	Retains inefficiencies of current model RES charging limited to opportunity charging Grid depot charging infrastructure with high GHG intensity

Option	Description	Opportunities	Challenges
Enhanced Partnership Contract CORRIDOR BASED	One year contract with additional opportunities	Improves incentives for fleet productivity Supports collaborative PT corridor improvement	Requires negotiation with operators and associations Some risks associated with RES depot charging
Concession CORRIDOR BASED	Operator bids include financial and technical competition. Potentially linked to corridor interventions/BRT	Enables performance-based competition Incentivises operator efficiency Enables private sector investment Addresses challenges with charging infrastructure	May require legal/institutional reform Will require careful engagement with operator associations

Option Development

- 11.41 Successful transition of urban bus fleets to e-bus operation requires system managers to develop an institutional and business model arrangement which:
- **Makes e-buses available to operators** in a way consistent with their financial and technical capabilities
 - **Apportions risk to the parties best able to manage it**, alongside any rewards for positive performance in asset management
 - **Maximises overall system cost efficiency** so as to minimise the overall operating cost base per km
 - **Ensures contractual arrangements deliver value for public system managers** while ensuring system sustainability for operators and incentivising efficient operation
 - **Ensures deliverability** within the existing institutional, legal, regulatory and political framework
- 11.42 Package up options and assessment based on deliverability and cost
- 11.43 Details and rationale for each option:

BM0: ICE Buses

- Vehicle is purchased by the public sector with a government backed loan to be repaid over 7 years.
- Depots and maintenance activities follow the 'business as usual' model.
- Operating contract remains for 1 year.

BM1: Business as Usual

- Vehicle and battery provided under existing model, same terms as existing lease
- Depot charging infrastructure (grid) provided by public sector with costs wrapped into lease
- Public opportunity charging infrastructure (green energy) provided on designated route at locations determined by MUB PTD by Charging as a Service provider.
- Operating contract remains for 1 year only, and based on fleet and with operator responsible for service planning

BM2: Enhanced Partnership Contract

- Vehicle and battery provided under existing public leasing model on 12-year term
- Depot charging infrastructure (green energy) provided by private sector charging-as-a-service operator with costs wrapped into lease
- Opportunity charging infrastructure (green energy) provided on designated route at locations determined through joint service planning by Charging as a Service provider.
- One-year operating contract, revised to incorporate corridor-based approach with public sector (bus priority) and private sector (performance targets) performance metrics to improve BEB productivity.
- Coordinated service and investment planning.

BM3: Operating Concession

- Vehicle and battery provided under existing public leasing model on 12-year term to successful concessionaire
- Opportunity charging infrastructure (green energy) provided on designated route at locations determined through joint service planning by Charging as a Service provider.

- Depot charging infrastructure (green) provided on operator facilities by private Charging-as-a-Service operator under joint concessionaire/public demand guarantee.
- Long term concession (12-year contract) provided, potentially enabling long term investment planning by public and private sectors

BM4: Fully Private Concession

- Same as BM3, except with the vehicle and battery provided by concessionaire through third party vehicle leasing arrangement

Economic Modelling of Business Model Options

Methodology

- 11.44 To support decision making, we undertook high-level financial modelling of the different business models to assess their impact upon the TCO (funding requirement) and cashflow (financing implications). Since it is assumed that the overall system cost will ultimately be funded through the gross cost contract framework, the TCO was considered from the perspective of the public sector. Cashflow was considered from both the public and private operator perspective, recognising that financing capacity is a relevant consideration for both parties in terms of e-bus feasibility.
- 11.45 This strategic financial modelling is intended to provide comparative analysis between each option. It is based upon cost data provided during stakeholder engagement and supplemented by international comparators where not available.
- 11.46 TCO per Km values are presented in real terms (2025 prices), discounted to 2025, at 3.5% discount rate. This is a standard approach in economic appraisal, and the intention is to reflect the fact that costs and benefits later in the future are of lower value than costs and benefits in the present. This does mean, however, that the costs are not reflective of the expected financial outlay.

Key variables

- 11.47 To assess the relative advantage of each option, we focused on the main factors that impact the total cost of e-buses from a capital and operating cost perspective. These factors include:
- 11.48 Capital cost financing rates:

- **Public e-bus leasing models (BM0-3)** have been based on an adaptation of the ICE bus leasing programme (BM0). This considers the nominal e-bus and battery cost repaid over 12 years (ICE bus is 7). Vehicles are assumed to transfer to operator ownership at the end of the lease period. From a public finance perspective, the TCO implication of this financing arrangement is 8.4% interest upon the capital owed by the operator (based on recent public bonds issued by Government of Mongolia)¹⁸⁹
- In the **Private Leasing Model (BM4)**, the bus and battery are procured by a third-party leasing company, with monthly lease payments over 12 years based on an equivalent financing cost of 13%. This is based on previous quotes by e-bus manufacturers for loan financing to operators. While this model will reduce the risk profile (as demand risk will be guaranteed by public sector through longer contracts) the leasing modality will transfer long-term technology performance risks from the operator to the leasing company. Considering these two factors, the net impact is expected to be neutral.
- **Depot and opportunity charging incorporating RES** is all modelled to be provided by private leasing (Charging as a Service), with costs based on modelled examples of microgrid charging developed as part of this report. These costs are all incorporated under 'Energy'.
- **Grid depot charging** (in BM1 only) is provided under public leasing, and incorporated under 'Infrastructure', with grid energy costs under energy.
- **Total KMs** – different contract regimes, performances targets and levels of infrastructure improvement will induce different levels of vehicle efficiency, and therefore different levels of total vehicle KMs. BM0 will provide the lowest efficiency (due to the absence of bus priority measures), followed by BM1 which will provide a 5% improvement (bus priority measures but fewer incentives). BM2 – BM4 will provide a 10% improvement compared to BM0.
- **Energy cost** – For BM0 energy costs are simply fuel costs. For BM1 they are a combination of opportunity charging rates (30% of energy) and depot charging (70%), with lower charging rates that are provided by the public sector. Opportunity charging rates include the setting up of charging infrastructure. For BM2, BM3 and BM4, 30% of energy cost are opportunity costs (same as BM1) and 70% is provided by the private sector at rates that capture the setting up of charging infrastructure as well.

¹⁸⁹ Basar, S. (2024, March 20). Mongolia's successful bond issuance in volatile times. *The Banker*.

<https://www.thebanker.com/Mongolia-s-successful-bond-issuance-in-volatile-times-1710924692>

- **Operating profit** – This aspect seeks to demonstrate the impact of the different financial return that a bus operator would require to provide services on top of the TCO (cost recovery). While it has not been possible to ascertain existing profit margins for bus operators in Ulaanbaatar¹⁹⁰, our model has considered how contract length and technology risk may affect this in relative terms.

Longer contracts would mean lower profit rates upon total costs because the private sector is facing a lower risk. In business cases for bus network investment in the UK, profit margins vary from 7.5% to 12%. These depends on various factors, including the level of competition, and operational risks. Shorter contracts present higher risks, and therefore we assumed that these will result in 10% profit margins, compared with 7.5% for longer contracts. The exception, however, is BM0, where profit margins are assumed to be 5% to reflect the lower risk of using old technology and existing operating arrangements.

¹⁹⁰ There is officially zero profit margin included in the hourly tariff calculation, which includes only operating costs and amortisation of capital costs. Nevertheless, it is understood from stakeholder engagement that there is a degree of profitability in the sector which is sufficient for local operators but has proven insufficient to attract international operators or investment. The assumptions in this report are therefore indicative and designed to capture the economic impact of different contractual arrangements in relative terms.

Table 11-12: Summary of business model options

Business Model	Investment cost and terms				Operating contract	
	Bus and Battery	Interest rate and repayment duration	Charging Infrastructure	Interest/Lease /Duration	Operation	Duration/Kms /Op Profit**
BM0: ICE Bus	Public Leasing	8.4% 7 years	n/a	n/a	Current Contract	1 year / 220km / 5%
BM1: e-BAU (Do Minimum)	Public Leasing	8.4% 12 years	Public Leasing (Depot, Grid) Private Leasing to MUB PTD (Opp, Green)	8.4% 12 years	Current Contract	1 year / As BM0 / 10%
BM2: BAU Plus	Public Leasing	8.4% 12 years	Charging as a Service*	n/a	Enhanced Contract (1 year)	1 year / BM0+10% / 10%
BM3: Public-Private	Public Leasing	8.4% 12 years	Charging as a Service*	n/a	Concession	12 year / BM0 +10% / 7.5%
BM4: Fully Private	Private Leasing	13% 12 years	Charging as a Service*	n/a	Concession	12 year / BM0% +10% / 10%

* Permits charging to be integrated on site of operator

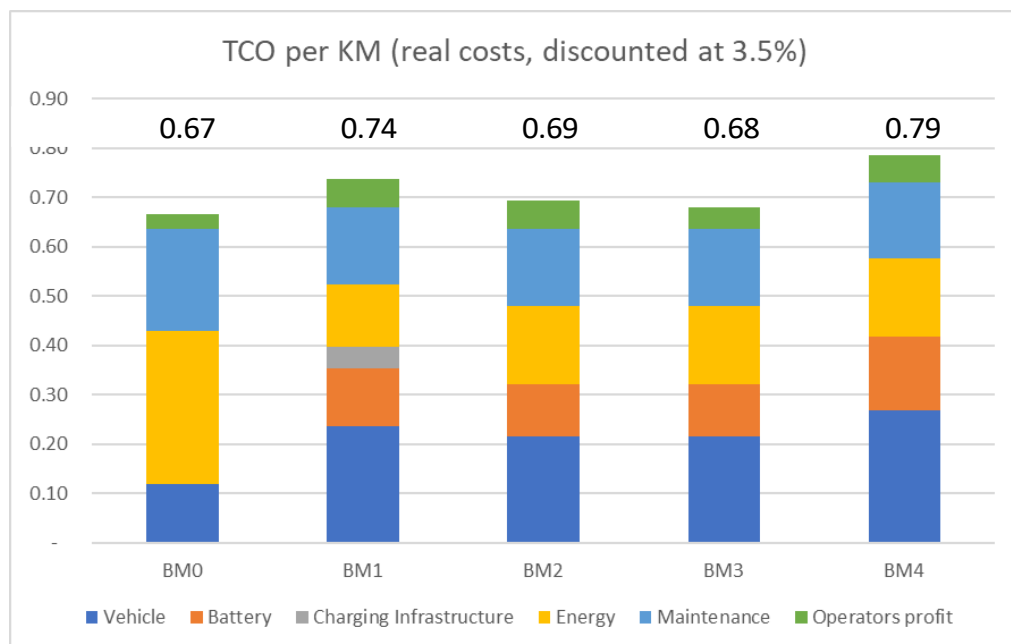
** Profit margins are based on the assumptions shown under 'Operating Profit' in paragraph 11.48

Key Findings

Total cost of ownership (public sector perspective)

- 11.49 Total Cost of Ownership per KM is shown in Figure 11-2, shown from the public sector perspective as the agency ultimately responsible for managing overall system cost through the gross cost contract system. The TCO is inclusive of financing costs and operator profit over the 12-year lifespan of the vehicles.
- 11.50 Overall, the ICE bus (BM0) remains the cheapest technology on a lifetime basis, with the lowest capital investment cost. BEBs, when implemented on the same basis as ICE buses, have a 10% cost premium. However operating models which incorporate bus priority, joint planning and green energy provision can nevertheless be achieved with a very marginal cost premium (BM2 and BM3 at 1 and 2% respectively) even accounting for financing costs and the increased operator risk premiums on their profit margins. This assumes that e-buses are a catalyst for public and political acceptability of high-quality bus priority measures such as BRT where typical diesel buses are not.
- BM4, which uses private financing for all capital components, has the highest overall cost. This is driven by the financing costs associated with the leasing model, although this would potentially achieve the transfer of risk of long-term vehicle and battery performance to a third party. By contrast, these aspects would be owned by MUB in BM1-3 (for bus and battery components).

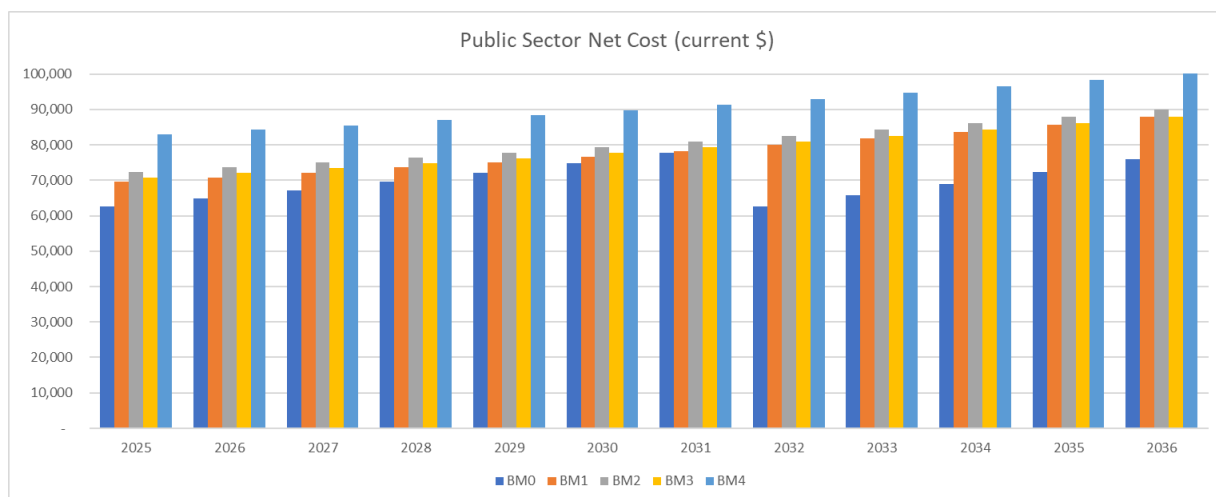
Figure 11-2: Total Cost of Ownership per KM from MUB perspective



Public sector cashflow

- 11.51 The table below shows public sector net cost over 12 years. It should be noted that the public sector cashflow for BM0-3 reflects the cost of capital and interest repayments for bus and battery (noting that capital outlay would be incurred in Year 1).

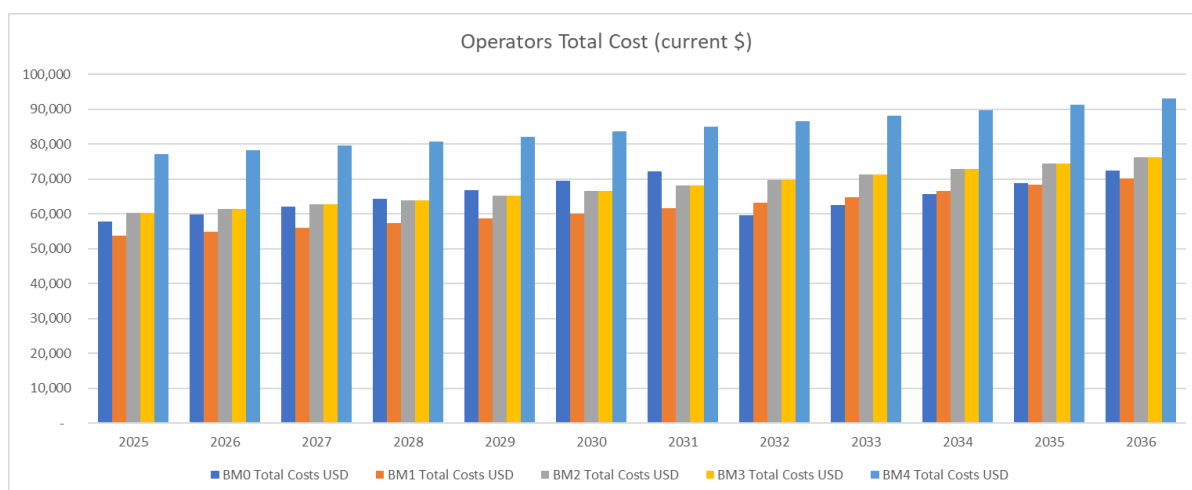
Figure 11-3: Public sector net cost over 12 years



Private operators cashflow

- 11.52 The table below shows private operators cost over 12 years.

Figure 11-4: Private operators cost over 12 years



Conclusion

- 11.53 Of the BEVs options (BM1 – 4), the best Value for Money (VfM) model, based on existing assumptions, is BM3 (closely followed by BM2). Nevertheless, the difference

between BM1 – BM4 is within 15%, within which the TCO alone is not necessarily the deciding factor and other non-measurable factors may impact long term TCO. These include:

- Ownership of overall project risk, including depot charging infrastructure, long-term fleet performance (and battery). This would favour long-term operating concessions in which operators have incentives for optimal use and maintenance of assets and ownership over capital intensive RES charging
- Incentives for efficiency and ownership/investment, particularly in charging infrastructure/RE but also in ensuring the long-term performance/maintenance of the fleet and collaboration to improve key operating metrics (e.g. bus priority measures).
- Furthermore, non-financial considerations will be important to consider, including deliverability in the current legal and regulatory framework and political acceptability of proposals in relation to Public Transport Operator associations.

Strategic Assessment & Recommendation

11.54 The Strategic Assessment is shown in Table 11-13 which considers multiple criteria for assessment. The overall findings are that:

- BM1 is technically deliverable, with no major institutional changes required. However, it would result in high operating costs (on account of no performance incentives) and the absence of a framework for implementing depot-based charging with off-grid RE means that it would deliver limited GHG mitigation benefits compared to diesel buses (9%). Without bus priority infrastructure it is unlikely to achieve GHG reduction through modal shift to public transport. Overall, it is unlikely to have a strong case for public investment.
- BM2 is a deliverable option to implement bus priority measures with e-buses without major institutional or legal changes to the current business model. It achieves strong GHG reduction (-40%) at a low TCO premium (+2%), however the reliance on operator-MUB PTD collaboration in lieu of strong contractual agreements exposes the public sector to risks over the long term with RES infrastructure deployed on operator depots.
- BM3 is the strongest performer from a GHG (-40%) and TCO (+1%) perspective. It combines public vehicle and battery leasing with long-term operating contracts, managing risks associated with charging infrastructure investment and providing performance incentives to the operator. The model, which is common in BEB and

conventional bus contracting, may be suitable for wider transition towards cost-competition in the urban bus contracting market in Ulaanbaatar. The requirement for a long-term operating concession may involve legal and institutional complexities, however it appears to comply with the objectives and intent of the Mongolian PPP framework.

- BM4 reduces the upfront costs associated with BM1-3, with private leasing of vehicle and battery (rather than public). This however comes at a substantial cost premium (+15%) and is likely to involve MUB PTD accepting or guaranteeing long term risks (financial, currency, demand) to enable operators to access financing. Considering that local operators are ill-equipped institutionally, technically and financially for the size or complexity of purchasing a BEB system, this is unlikely to be a realistic option for the current operator market. It may however be a suitable operating model for bus-based mass transit options (e.g. BRT) in which the market is opened to international operators.

Conclusion

- 11.55 Overall, BM3 is the strongest option for implementing BEBs in Ulaanbaatar and should be pursued in the first instance. BM2 may be suitable for further development and implementation, particularly as an interim model while developing longer term concessions.

Table 11-13: Summary appraisal of e-bus business model options

	Parameters	BM1	BM2	BM3	BM4
		Do Minimum	Enhanced Partnership	Operating Concession	Fully Private Concession
Economics and Financing	Lifetime Cost to MUB (TCO km)	0.74\$	0.69\$	0.68\$	0.79\$
	TCO change vs ICE bus	+9%	+3%	+1%	+15%
	Upfront Capital Cost	High	High	High	Low
	GHG reduction per km vs ICE bus	-9%	-40%	-40%	-40%
	Public Involvement	Purchase of e-buses and depot chargers (with some experience)	Purchase of bus and battery	Purchase of bus and battery	Provision of long-term demand guarantees
	Risk Management Issues	Moderate Depot Charging with 1 year contract (non-RES)	High RES investment with 1 year contract	Low RES investment but long-term contract	Potentially high-Operator investment decisions guaranteed by public sector. Local operators have no experience of EV planning.
Risks and Performance	Technology Risks	Public Sector	Public Sector	Public Sector	Private Sector
	Operating Incentives	Insufficient	Moderate, Collaborative	Strong, Contractual	Strong, Contractual
Deliverability	Institutional Challenges	Low As BAU	Low-Moderate Requires negotiation of new contract model with operators	Moderate Requires transition from service contract to concession (acceptability to operators).	Difficult As BM3 but with additional financial guarantees and operator strengthening.
	Legal Challenges	Easy As BAU	Moderate Legal arrangements around RES provision on private depots.	Moderate-Difficult Delivery of PPP model for urban bus operation	Difficult Delivery of PPP model for urban bus operation and investment

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Appendix A: Market Development Incentive Selection

11.57 Based on the effectiveness of an incentive in overcoming a barrier to electrification for each segment and the incentive's deliverability (its feasibility and acceptability to local stakeholders, as discovered during an in-country workshop), a level of suitability has been made for each incentive in relation to each segment it is relevant to:

- Highly suitable – the incentive has a strong potential to address a barrier to electrification for the segment and believed to be feasible and acceptable to stakeholders.
- Suitable – the incentive is strong in terms of either its effectiveness or deliverability/acceptability, but is moderate in the other criteria.
- Suitable with specific conditions – certain incentives could work well, but only under certain circumstances, so they are only tentatively recommended.
- Not suitable - the incentive would have low effectiveness and/or low feasibility/acceptability in Mongolia.

Incentive Assessment

Table A-14: Incentive assessment by mode

Vehicle segment	Barriers to e-mobility adoption	Incentive	Financial or non-financial	Description	How the incentive addresses the barrier(s)	Extent issue is addressed (effectiveness)	Deliverability (feasibility & acceptability)	Suitability
Urban bus	Moderate-high TCO differential Limited overall GHG emissions impact with current energy mix	Capital Subsidy on Purchase of E-buses	Financial	Capital grant to reduce the cost of purchase of EVs Often only applies to EV operators. This can be limited programmatic intervention with gradually reducing subsidies and capped to a specific number of EVs. The subsidy could be extended only to EVs meeting 1) advance battery chemistries 2) defined quality and safety standards 3) defined localisation and other set parameters. This subsidy can be linked to EVs’ performance, measured in terms of battery capacity (kWh), as this is the primary contributing factor to EVs’ higher cost. It can be gradually phased-out as EV reaches ICE price parity	Moderate-high TCO differential: Depending on the subsidy level, this would make BEBs more price competitive to ICEVs on a TCO level (making up for their typically higher initial capital cost) Since the public sector (MUB PTD) is currently responsible for purchasing buses, capital subsidy would need to be external to MUB (e.g. national government or development cooperation). High upfront cost: Depending on the subsidy level, this would reduce public sector financing burden for BEB implementation.	High effectiveness: A capital subsidy for e-buses could allow the MUB PTD to provide financial incentives to operators to transition to an electric fleet. Low-moderate effectiveness: At a subsidy level to the TCO between BEB and ICEVs, this would make BEBs more price competitive to ICEVs. However, given CapEx is three times higher but TCO is only 10-20% private operators would still not be able to finance BEBs.	Low feasibility/acceptability: The funding for the subsidy would have to be external for this incentive to work. This is unlikely to materialise in the short-term at least. Other mechanisms may more effectively mitigate TCO issues, such as improving bus operating performance.	Not suitable: It is unlikely that external funding for this subsidy will materialise in the short-term at least.

		Introduction of Battery Leasing Mechanisms for E-buses	Financial	The cost of e-bus battery would be separated out from the cost of the rest of the vehicle. The MUB PTD would likely continue to fund the capital cost of the vehicle while the upfront cost of the battery would be financed by an independent FI and leased to either the operator the MUB PTD.	High upfront cost: This would substantially reduce the initial capital burden on the MUB PTD, as 30-40% of an e-bus cost lies in the battery. Although it would slightly increase the TCO, this could reduce the capital burden on the MUB PTD, if an independent FI funded the upfront battery cost. In both cases, it would protect the operator from the upfront battery cost.	Low-Moderate effectiveness: While it would make capital costs manageable for MUB, the conversion of Capex to higher Opex (including private financing) would exacerbate existing system financial issues (which are arguably a greater sector priority).	Low feasibility-acceptability: While battery leasing is technically feasible, its benefits are outweighed by its impact on TCO and wider system financial sustainability. Stakeholder engagement indicated this incentive was not suitable.	Not suitable: This would be a difficult incentive to introduce in practice, and one that is not seen favourably by stakeholders.

		Encouraging Banks to Finance (PT) EVs	Financial	Given the nascency of PT EV technology and its adoption, Financial Institutions (FIs) such as banks and Nonbank Finance Companies (NBFCs) are not lending to EVs due to associated asset (e.g., technology, resale, manufacturer, etc.) and business model (operation and maintenance, utilisation, etc.) risks. FIs see a high risk from the EV sector. These risks are both real (e.g., uncertainty of resale value) and perceived (e.g., product quality). Higher capital costs for BEBs require purchasers to borrow greater amounts, creating challenges both in terms of securing the financing (risk) and the feasibility of the financing costs (particularly for an asset with a 12 year+ lifespan). Commercial private sector rates in Mongolia (in MNT) are approximately 18% for used buses, making long-term financing for e-buses unviable for private operators. Various mechanisms can be used to support banks and non-banking finance companies (NBFCs) to finance PT EVs to ease and lower cost of financing EVs. It could be achieved, in addition to the concessional financing already offered through the Mongolian Green Finance Corporation, through setting up a guarantee fund to reduce the risk of loans for operators. Providing guarantees to private operators for currency-related risks to enable them to make capital investment using lower-interest foreign currency denominated financing. This could enable longer-term loans and/or lower interest rates.	Moderate-high TCO differential / High upfront costs The encouragement of FIs and NBFCs through incentives and attractive financing options could enable private sector investment in BEB fleet, reducing the capital investment requirement for new e-buses to the MUB PTD/government. Private investment is likely to remain a more expensive financing mechanism to public investment (even with incentives), and so will increase TCO relative to BAU. However, with appropriate risk apportionment it can reduce the TCO relative to purely private investment.	Low effectiveness: It would reduce the cost of purchasing BEBs for private operators compared to using purely commercial loans, but this would still lead to a greater TCO than diesel buses, so it is unlikely to persuade operators to purchase BEBs in isolation. This view was shared by key stakeholders at a workshop discussing potential incentives for e-mobility adoption.	Moderate-High feasibility/acceptability: If climate financing could be used as a source for a guarantee fund for low interest investments, this would significantly limit the financial risks for the Government. Stakeholder engagement suggested this would be an acceptable incentive.	Not suitable: Although this would not be as expensive as funding subsidies and loans directly, it would not reduce the TCO of BEBs enough to make them viable for private operators in isolation.

		Private leasing model	Financial	The e-buses are availed on lease by the operators based on contract/agreement. This can be directly with a manufacturer, or through an independent FI or the MUB PTD, who would by the vehicles and lease them to operators (as the MUB PTD currently does with diesel buses).	Moderate-high TCO differential /MUB PTD unable to independently fund bus fleet renewal under current business model: This model helps to address the upfront financing issues for the operators by converting CAPEX costs to OPEX costs. However, in the case of buses, diesel buses are already leased to operators by the MUB PTD, and e-buses are provided with a lower re-imbursement tariff to reflect the reduced financial burden on the operator. For this to work as an incentive for e-buses, the MUB PTD would need to stop leasing diesel buses to operators and stop buying e-buses outright.	Moderate-high effectiveness: Would help to keep capital costs manageable for the MUB PTD. Assuming the MUB PTD stopped purchasing and leasing diesel buses, providing a leasing mechanism (either themselves or through an FI) would provide a strong incentive to move to e-buses for operators. Private leasing likely to have significant higher lifetime cost than public financing (which would need to be balanced against efficiency gains).	Low-moderate feasibility/acceptability: This would require a significant change to the current bus business model to allow long-term contracts. However, government stakeholders seemed open to the idea of bus model reform, although were less sure of its feasibility.	Suitable (long-term): This is not a high priority “quick win”. But it could prove effective in the future.

		Charging-as-a-service model	Financial	Involves the fleet operators using charging services from subscribed charging service providers. In the case of BEBs, this would include provision of both charging services and also off-grid renewable energy sources. Options include both opportunity and depot charging services.	Moderate-high TCO differential / MUB PTD unable to independently fund bus fleet renewal under current business model: This model will help the operators avoiding the upfront cost required for setting up the charging infrastructure. Instead, they pay a regular subscription for the service, helping to make the payments more manageable. High grid impact / Limited overall GHG emissions impact with current energy mix: Charging-as-a-service providers are more likely to utilise smart charging technology and will therefore encourage PT operators to charge their vehicles at times when there is less demand on the network. This will reduce the requirement for fossil fuels to meet the electricity demand of charging EVs.	High effectiveness: While the addition of a charging service provider potentially adds financing cost, the ability to bring international private sector experience in RES and BEB charging strategies may outweigh this in TCO terms.	High feasibility/ acceptability: And internationally established model and Charging-as-a-Service providers likely be interested in the Mongolian market subject to clarity and long-term guarantees over the asset lifetime. For depot-based charging, this may require longer operator contracts. Deemed acceptable by stakeholders.	Highly suitable: Although not necessary to facilitate the electrification of the bus network, it could provide important financial support whilst taking pressure off the grid.

		Introduction of Contract Benefits for PT EV Operators	Non-financial	For buses, this could include bundling routes for operators with an EV fleet (i.e. a service provider operating a route with BEBs will be automatically awarded another route to serve on).	Moderate-high TCO differential: This could help to provide economies of scale with more routes able to be operated with much of the existing infrastructure required to run a bus fleet already in place.	Moderate effectiveness: Whilst contract incentives would not reduce the TCO differential of e-buses, they could help to incentivise bus operators to adopt BEBs by being able to operate more routes and increase revenues.	Low feasibility: Given the contract period for routes is one year and private companies are unable to finance BEB purchases using commercial loans, it is unlikely to work as an incentive without wider reform/other financial assistance for operators.	Not suitable: This would require greater structural/financial changes to be acted upon by private operators, and even then, the strength of the incentive would be limited.
		E-Bus Only Corridors	Non-financial	Enforced corridors exclusively for e-bus operation, providing a visible 'Green Corridor' to showcase improvement to air quality improvements and accompanied by stronger enforcement of public transport priority (either fine enforcement or physical segregation).	Limited overall GHG emissions impact with current energy mix: This will help to enhance the GHG emissions reduction impact by encouraging greater adoption of e-buses. Operators would be incentivised to provide better services on all routes to be considered for e-bus fleet renewal by the MUB PTD, as the ability to use e-bus only corridors would provide a significant advantage over competition, provided a popular corridor was chosen. It would also ensure the efficient operation of e-buses, making them more technically and financially viable, whilst also improving their emissions reductions compared to diesel buses.	Moderate-high effectiveness: Whilst this doesn't directly address the energy mix issue, it would create an enabling environment for e-buses, making them more attractive to operators, who might therefore invest in electrifying their fleet. It could act as the catalyst for further air quality improvements along the corridor.	Moderate-high feasibility/acceptability: MUB PTD has contractual control over routes. The contracts could be amended to stipulate only e-buses to operate on routes along a particular corridor. It would require significant investment in e-buses and bus priority infrastructure.	Suitable: This incentive could form part of a wider package of operational improvements and incentives to promote the adoption of BEBs. For BEBs to provide significant GHG reduction benefits and operate efficiently, it would be essential they are able to operate with strong bus priority.

		EV Charger Subsidy	Financial	A capital subsidy provided by the government to fleet owners/operators to alleviate some of the upfront capital burden cost of charging facilities. The subsidy may stipulate conditions, such as charger specification requirements or on-site RES to power the chargers, and provide advice on charging equipment and installation.	Moderate-high TCO differential: The capital cost of chargers and their installation is a significant portion of the cost of fleet conversion for fleet owners/operators. This is also an area that is less well understood by fleet owners/operators, so advice/requirements could provide them with guidance to encourage a transition to e-buses.	High effectiveness: This would help to equalise the TCO differential between EVs and ICEVs. It may also alleviate uncertainty around EV fleet transition. If RES was required to be installed in conjunction, it improve the GHG emissions reduction.	Moderate feasibility/acceptability: A subsidy of charging facilities should be feasible for the government, given the lower capital costs involved.	Suitable: The support, not just financial, this would give to operators would be worth the investment in a subsidy. If the government could not fund the subsidy itself entirely, it could seek support from FIs. This should be packaged with RES incentives to boost the green credentials.
		EURO V Fuel Standard	Non-financial	Euro V fuel standards set a maximum sulphur content of 10ppm in petroleum fuel, which limits the PM emissions from ICEVs. This is good for the air quality of UB but it will mean the price of petroleum fuel is likely to rise slightly. Whilst not a reason to introduce the EURO V fuel standard in itself, it will raise the TCO of ICEVs, making them more comparable with EVs.	Moderate-high TCO differential: The slightly higher fuel price for ICEVs will bring their TCO closer to EVs. It will also help to make the residual ICEV buses (still the majority of buses in UB) less harmful to air quality.	Low-moderate effectiveness: The equalising effect of the TCOs would be fairly small – the key issue would still be upfront capital cost.	High acceptability/moderate feasibility: MOET already has the ambition of EURO V fuel by 2030. Mongolia's heavy reliance on one supplier may be an issue in guaranteeing EURO V fuel, but a large proportion of fuel imported is already EURO V.	Suitable: Whilst the case for introducing EURO V fuel standards for the purpose of incentivising e-mobility may not be enough on its own, the EURO V standard is already planned to be brought in and should be implemented mainly for its air quality benefits. The co-benefits for EVs are a bonus.

Private cars (mass market) & (mid-range/new)	<u>Mass market</u> Moderate TCO differential Low supply of electric cars (both new and second-hand) into Mongolia currently, & low potential supply from historical trade partners (mostly Japan) Moderate-low GHG reduction & air quality impact (due to low average mileage & high prevalence of HEV cars) <u>Mid-range/new market</u> Moderate supply of <i>mid-range</i> vehicles, due to competition with Chinese domestic market for used vehicles (no supply chain issues for <i>new</i> vehicles) Moderate-low impact on GHG	Reduction of Taxation on private EVs	Financial	Customs tax and/or VAT and/or road tax reduction can be applied to EVs. Often these reductions are generous to begin with and gradually reduce to the same as ICEVs as EVs become more popular/affordable.	Moderate TCO differential: This makes EV more price competitive compared to ICEVs (making up for their typically higher initial capital cost). EVs already benefit from the lowest customs tax band. However, other import costs, such as transportation and customs duties in other countries, and a higher vehicle cost on average contribute to EVs’ higher TCO than ICEVs.	Mass market Low-moderate effectiveness: EVs already benefit from reduced excise duty taxation. As customs and import taxes are applied to the vehicle value and are already relatively low (5% and 10% respectively), any reductions in these taxes would not make EVs price competitive with ICEVs and HEVs. Mid-range/new market Moderate-high effectiveness: As the vehicle cost of ICEVs and EVs are more comparable, reductions in customs tax and VAT (excise duty is already low) for EVs could make them much more attractive to this market.	Mass & mid-range/new market High feasibility: Excise duties for EVs are already differentiated from ICEVs and most HEVs. As customs taxes and VAT are not differentiated by engine type and age, it would be slightly more complicated to introduce EV-only rates, but this would be very feasible.	Suitable in the short-term: VAT and customs tax reductions could make EVs in this segment competitive enough for consumers to bare the initial higher capital costs for lower maintenance and fuel costs. However, as more EVs become more popular, this incentive will become more expensive for the Government.

	emissions & air quality	Capital Subsidy on Purchase of EVs	Financial	Capital grant to reduce the cost of purchase of EVs This can be limited programmatic intervention with gradually reducing subsidies and capped to a specific number of EVs. The subsidy could be extended only to EVs meeting 1) advance battery chemistries 2) defined quality and safety standards 3) defined localisation and other set parameters. This subsidy can be linked to EVs’ performance, measured in terms of battery capacity (kWh), as this is the primary contributing factor to EVs’ higher cost. It can be gradually phased-out as EV reaches ICE price parity.	Moderate TCO differential: This would make EVs more price competitive compared to ICEVs (making up for their typically higher initial capital cost).	Mass market Low-moderate effectiveness: While much higher vehicle cost of EVs (vs ICE or HEV) is a key barrier, the scale of subsidy required per vehicle would be very high. Subsidy would also not address the global supply constraint of suitable used entry level EVs. Mid-range/new market High effectiveness: As the vehicle cost of ICEVs and EVs are more comparable, a capital subsidy on EVs could make them very competitive in this segment, with their lower operating costs.	Mass market Low feasibility/acceptability: The subsidy would have to be very high in this segment to bring the TCO of new EVs down to a level comparable with the current second hand HEV market. The Government would not be able to afford the level of subsidy required to make this incentive effective. Mid-range/new market Low feasibility/acceptability: The Government would not be able to afford the level of subsidy required to make this incentive effective.	Not suitable: Whilst this would be very attractive to consumers, it isn’t feasible for the Government to introduce.

		Encouraging Banks to Finance EVs	Financial	Given the nascency of EV technology and its adoption, Financial Institutions (FIs) such as banks and non-banking finance companies (NBFCs) are not lending to EVs due to associated asset risks (e.g., technology, resale, manufacturer, etc.). FIs see a high risk from the EV sector. These risks are both real (e.g., uncertainty of resale value) and perceived (e.g., product quality). Higher capital costs for EVs require purchasers to borrow greater amounts, creating challenges both in terms of securing the financing (risk) and the feasibility of the financing costs. Commercial private sector rates in Mongolia (in MNT) are approximately 18% for used buses, making long-term financing for EVs unviable for many operators. Various mechanisms can be used to support banks and non-banking finance companies (NBFCs) to finance EVs to ease and lower cost of financing EVs. It can be achieved, in addition to the concessional financing already offered through the Mongolian Green Finance Corporation, through setting up a guarantee fund to reduce the risk of loans for operators.	Moderate TCO differential: The encouragement of FIs and NFBCs through incentives and attractive financing options should help individuals pay for EVs by reducing the initial capital burden and the cost of the vehicle more manageable for owners. Private investment is likely to remain a more expensive financing mechanism to public investment (even with incentives), and so will increase TCO relative to BAU. However, with appropriate risk apportionment it can reduce the TCO relative purely private investment.	Mass market & Mid-range/new market Moderate-high effectiveness: It would reduce the extent of personal borrowing from private car owners, which is one of the key barriers to further adoption of EVs. This view was shared by key stakeholders at a workshop discussing potential incentives for e-mobility adoption.	Mass market & Mid-range/new market Moderate-high feasibility: If climate financing could be used as a source for a guarantee fund for low interest investments, this would significantly limit the financial risks for the Government. Stakeholder engagement suggested this would be an acceptable incentive.	Suitable: Although some public financial backing would be required to guarantee private loans, it would not be as expensive as funding subsidies and loans directly.

		Access to bus lanes for EVs	Non-financial	Through number plate recognition, private EVs allowed in bus lanes to bypass traffic.	Although it doesn't directly address the issue, it may make the moderate TCO differential more palatable if the higher cost comes with the ability to bypass traffic. However, many bus lanes are already frequently used by private cars which are not allowed in them. It would also reduce the attractiveness of buses for the routes where bus lanes are enforced (e.g. Peace Avenue).	Mass market & Mid-range/new market Low-moderate effectiveness: This may work as an incentive for a short period of time (for early adopters). However, only a few bus lanes are currently adhered to, so the incentive would be limited. And it would have to be repealed once the number of EVs started to affect bus operations. This may result in backlash if motorists bought EVs on the understanding they would be able to drive in bus lanes.	Mass market & Mid-range/new market Medium feasibility/low acceptability: This could be achieved through number plate recognition camera enforcement. However, enforcement of bus lanes is already weak in UB, and this may cause the few lanes that are enforced well to break down, as drivers may not realise that only EVs are allowed to drive in bus lanes. MUB and MRTD are against this proposal.	Not suitable: This would not be an effective incentive, would only benefit the very earliest adopters, and would have to be repealed shortly after its introduction.

		Parking benefits for EVs	Non-financial	Through number plate recognition, private EVs allowed to park for free/at reduced costs/in EV-only spaces.	Although it doesn't directly address the issue, it may make the moderate TCO differential more palatable if the higher cost comes with the ability to park more easily/cheaply in the city.	Mass market & Mid-range/new market Low-moderate effectiveness: Again, this would work for a short time, but as EVs become more popular, this incentive will be nullified. This would be easier to repeal than admission to bus lanes.	Mass market & Mid-range/new market Moderate feasibility/acceptability: Whilst the technology required to implement this incentive would not be advanced, it would require that parking in UB would need to be controlled. Greater controls around parking are likely to be implemented as part of USUTP's Smart Parking Management component. Stakeholders seemed open to the idea.	Mass market & Mid-range/new market Suitable in the short-term: This would be effective for a short time to encourage early adopters and could be easily repealed/expansion of scheme stopped once the proportion of EVs becomes so great that it is nullified as an incentive.

		Exemption of Annual Vehicle Registration Charges on EVs	Financial	Similar to the tax exemption. Could be applied in the short term. Could be a reduction rather than exemption. Depending on the cost of vehicle registration, may be more symbolic than a strong monetary incentive (makes up a small portion of TCO).	Moderate TCO differential: This would make EVs slightly more price competitive compared to ICEVs.	Mass market Low effectiveness: One of the main barriers to electric private car adoption for the mass market is the much higher capital cost of EVs. However, vehicle registration costs are not a significant portion of an EV's TCO, so this would not be enough to persuade mass market customers to switch to an EV from an ICEV. Mid-range/new market Low-moderate effectiveness: Again, the vehicle registration charge makes up a very small portion of a vehicle's TCO in this segment. It would be a welcome incentive to prospective EV buyers, but it is unlikely to incentivise EV purchases on its own.	Mass market & Mid-range/new market Moderate-high feasibility: The annual vehicle registration charge could be easily repealed for EV owners from an administration perspective.	Not suitable: The incentive is unlikely to justify the loss of revenue generated by the vehicle registration charge.

		Exemption from toll fees	Financial	Number plate recognition could be used to exempt EVs from toll fees (similar to how they are exempt from number plate restriction days).	Moderate TCO differential: This would make EVs slightly more price competitive compared to ICEVs.	Mass market & Mid-range/new market Low-moderate effectiveness: Tolls are a small portion of a car’s TCO, and only apply to long-range trips, which an EV is less likely to be used for in the short-term. It's possible that an exemption from tolls may have a disproportionately large “nudge” effect for the few times tolls are used.	Mass market Low feasibility: Similar to access to bus lanes and parking incentives, once EV cost relative to ICEV cost means that exemption from tolls becomes an incentive, this incentive will become unfeasible. The revenue loss would be too great. Mid-range/new market High feasibility: EVs could carry some form of identification which could either be automatically identified by a camera or by a toll booth attendant. Views of the incentive from stakeholders were mixed. Some were unsure whether the incentive would justify the loss of revenue, but some were very positive.	Not suitable: Although feasible, the number of times tolls would be used by early adopters would not provide enough of a nudge to make it worthwhile. In the long-term, as ranges improve and EVs are more widely adopted, although tolls may be used more frequently, this incentive may become too expensive to provide.

		EV only-restriction at EV charging spaces	Non-financial	Mandate and enforce charging EVs-only at charging station spaces in public car parks.	Range anxiety: Cold conditions will mean significantly reduced ranges, and opportunity charging away from home during the day will be needed, particularly during early adoption. Drivers will need re-assuring that they will be able to park and charge during the day, especially in the short- to medium-term.	Mass market & Mid-range/new market High effectiveness: EV charging spaces should be protected for their intended purpose, even as EVs enter the mass-market. This will not only provide assurance to drivers that they will be able to opportunity charge when necessary, this will help to keep chargers commercially viable and support their expansion. Range anxiety will reduce in the long-term as technology improves, so this will be less necessary.	Mass market & Mid-range/new market High feasibility: Could be easily enforced either by parking attendants or cameras.	Suitable: Protecting EV charger spaces is important for reducing range anxiety concerns in the future. It will also support commercial charging stations by ensuring they are generating revenue when the parking space is occupied. However, it will influence the decision to purchase an EV less than the capital cost of EVs, for instance.

		EV Charger Subsidy	Financial	A captive EV charging station is a charging station that is owned and operated by a private entity, such as a business, apartment complex, or government agency. These stations are typically only accessible to the people who own or lease property from the entity that owns the station. A capital subsidy provided to these private entities could alleviate some of the upfront capital burden cost of charging facilities. The subsidy may stipulate conditions, such as charger specification requirements or RES generation, and provide advice on charging equipment and installation.	Moderate-high TCO differential: The capital cost of chargers and their installation is a significant portion of the cost of EV ownership. Therefore, if individuals could avoid this cost by being provided with captive charging options, this could make EVs significantly more attractive. This may be the only way to provide home charging to individuals living in apartments. This is also an area that is less well understood by individuals and private entities, so advice/requirements could provide them with guidance to encourage a transition to EVs.	Mass market & Mid-range/new market Moderate-high effectiveness: This could help to provide home charging options to those without off-street parking, by improving the viability of semi-public on-street charging. However, this will only help those in medium- to high-density population areas.	Mass market & Mid-range/new market Moderate feasibility: The financial burden of this subsidy would be much less than a subsidy for vehicles. However, it would still require significant funds, depending on the level of subsidy required.	Suitable: This incentive could have a broad reach, but the funding implications would need to be carefully managed.
		EURO V Fuel Standard	Non-financial	Euro V fuel standards set a maximum sulphur content of 10ppm in petroleum fuel, which limits the PM emissions from ICEVs. This is good for the air quality of UB but it will mean the price of petroleum fuel is likely to rise slightly. Whilst not a reason to introduce the EURO V fuel standard in itself, it will raise the TCO of ICEVs, making them more comparable with EVs.	Moderate-high TCO differential: The slightly higher fuel price for ICEVs will bring their TCO closer to EVs. It will also help to make the residual ICEVs (still the majority of automobiles in UB) less harmful to air quality.	Low-moderate effectiveness: The equalising effect of the TCOs would be fairly small – the key issue would still be upfront capital cost.	High acceptability/moderate feasibility: MOET already has the ambition of EURO V fuel by 2030. Mongolia's heavy reliance on one supplier may be an issue in guaranteeing EURO V fuel, but a large proportion of fuel imported is already EURO V.	Suitable: Whilst the case for introducing EURO V fuel standards for the purpose of incentivising e-mobility may not be enough on its own, the EURO V standard is already planned to be brought in and should be implemented mainly for its air quality benefits. The co-benefits for EVs are a bonus.

		Mandate for Citizens to be Able to Request that Public and Commercial Car Parking Spaces be Restricted to EVs/EV Charging Stations Installed	Non-financial	Give citizens the right to request EV-only parking spaces and/or public EV chargers at public car parks (including on-street parking). This would help to ensure parking spaces and chargers are prioritised where demand is highest. It could be facilitated through an online tool or app.	Range anxiety: Cold conditions will mean significantly reduced ranges, and opportunity charging away from home during the day will be needed along with the assurance of parking spaces, particularly during early adoption. Drivers will need re-assuring that they will be able to park and charge during the day, especially in the short- to medium-term.	High effectiveness: This would help to target EV charging stations and parking spaces to demand.	Moderate-high feasibility: This would ideally be a technology-enabled solution, which could be helped by the private sector. Or it could be a low-tech solution. Providing & enforcing EV-only spaces would be relatively simple. Providing EV public chargers would be more expensive, but there are already public chargers in UB.	Highly suitable: This is a reasonably simple solution that will help to target chargers and parking spaces more effectively to demand.
		Right to Install EV Chargers in Communal Residential Parking Lots	Non-financial	Give citizens living in apartment blocks and other residences with communal parking lots the right to install home chargers in their shared parking facilities. Many of UB’s citizens live in apartments. Not all apartments have communal parking lots for their residents, but this will help a substantial proportion of the population.	Range anxiety: Cold conditions will mean significantly reduced ranges, and home charging will be needed to ensure affordable charging, as well as the opportunity for cold climate mitigation measures such as pre-heating.	High effectiveness: A key barrier for many of UB’s citizens to EVs will be the inability to charge at their home. Affording a home charge may not be easy, but subsidies and financing could help with this. A good initial step is the ability to install a charger in the first place.	High feasibility: This would take some planning legislation. There would need to be an assessment of the grid impact of each application.	Highly suitable: For EVs to be affordable and practical, citizens need to have the right to be able to charge at home. This provides the foundations for that to be possible for many.

Taxi cars (mass market)	Delivery may be challenging due to a currently fragmented and largely informal market Range anxiety Moderate market readiness (relatively low existing supply of vehicles in traditional supplier countries) Moderate reduction in reliance on private cars	Capital Subsidy on Purchase of E-taxis	Financial	Capital grant to reduce the cost of purchase of EVs. Often only applies to EV operators. This can be limited programmatic intervention with gradually reducing subsidies and capped to a specific number of EVs. The subsidy could be extended only to EVs meeting 1) advance battery chemistries 2) defined quality and safety standards 3) defined localisation and other set parameters. This subsidy can be linked to EVs' performance, measured in terms of battery capacity (kWh), as this is the primary contributing factor to EVs' higher cost. It can be gradually phased-out as EV reaches ICE price parity.	High initial capital cost of EVs: This would make them more price competitive compared to ICEVs (making up for their typically higher initial capital cost). The market is currently fragmented and largely informal, which would make it difficult to distribute the subsidy, even if the funding was available. However, a process to formalise the taxi sector is currently underway, which may alleviate some of these issues.	High effectiveness: If the sector was formalised and the subsidy could be distributed to operators, the subsidy would be very effective at lowering the capital cost of EVs closer to parity with HEV/ICE equivalents.	Low feasibility: The Government would not be able to afford the level of subsidy required to make this incentive effective.	Not suitable: Although it would be an effective incentive, the Government would not be able to afford it.
		Introduction of Battery Leasing Mechanisms for E-taxis	Financial	The cost of EV battery is separated out from the cost of the rest of the vehicle for the operator. The operator funds the cost of the rest of the vehicle upfront, whilst a third party bears the capital cost of the battery and then leases the battery to the operator. The operator incrementally pays the third party for the cost of the battery over time, making the payment more manageable for the operator.	High initial capital cost of EVs: This would substantially reduce the initial capital burden on operators, as a substantial portion of an EV cost lies in the battery. Although it would slightly increase the TCO, operators would find managing the expenditure more feasible if the battery cost was converted to OPEX from CAPEX. The market is currently fragmented and largely informal, which would make it difficult to organise a battery leasing mechanism, even if the funding was available. However, a process to formalise the taxi sector is currently underway, which may alleviate some of these issues.	High effectiveness: Private taxi operators have more control of their fleet renewal than bus operators, so if a battery leasing mechanism could be organised, it would be very effective.	Low feasibility: However, many taxis are operated by individuals either informally or through ride-sharing platforms, so this would be difficult to organise. The Government would also struggle to fund this battery leasing mechanism, so an external financier would be required.	Suitable only if taxi sector is formalised: This incentive could be effective in encouraging the adoption of EVs, but proving it will be used for a vehicle to be used as a taxi will be very hard unless the sector is much more formalised than it currently is.

		Encouraging Banks to Finance (PT) EVs	Financial	Given the nascency of PT EV technology and its adoption, Financial Institutions (FIs) such as banks and NBFCs are not lending to EVs due to associated asset (e.g., technology, resale, manufacturer, etc.) and business model (operation and maintenance, utilisation, etc.) risks. FIs see a high risk from the EV sector. These risks are both real (e.g., uncertainty of resale value) and perceived (e.g., product quality). Higher capital costs for EVs require purchasers to borrow greater amounts, creating challenges both in terms of securing the financing (risk) and the feasibility of the financing costs. Commercial private sector rates in Mongolia (in MNT) are approximately 18% for used buses, making long-term financing for EVs unviable for many operators. Various mechanisms can be used to support banks and non-banking finance companies (NBFCs) to finance PT EVs to ease and lower cost of financing EVs. It can be achieved, in addition to the concessional financing already offered through the Mongolian Green Finance Corporation, through setting up a guarantee fund to reduce the risk of loans for operators.	High initial capital cost of EVs: The encouragement of FIs and NBFCs through incentives and attractive financing options should help taxi operators pay for EVs by reducing the initial capital burden and the cost of the vehicle more manageable for owners. Private investment is likely to remain a more expensive financing mechanism to public investment (even with incentives), and so will increase TCO relative to BAU. However, with appropriate risk apportionment it can reduce the TCO relative purely private investment.	Moderate-high effectiveness: It would reduce the borrowing requirement for taxi operators, which is one of the key barriers to further adoption of EVs. This view was shared by key stakeholders at a workshop discussing potential incentives for e-mobility adoption.	Moderate-high feasibility: If climate financing could be used as a source for a guarantee fund for low interest investments, this would significantly limit the financial risks for the Government. Stakeholder engagement suggested this would be an acceptable incentive.	Suitable: Although some public financial backing would be required to guarantee private loans, it would not be as expensive as funding subsidies and loans directly.
		EV/Public leasing model	Financial	The e-taxis are availed on lease by the operators based on contract/agreement, either directly with a manufacturer or through a third-party financing organisation.	High initial capital cost of EVs: This model helps to address the upfront financing issues for the operators by converting CAPEX costs to OPEX costs.	High effectiveness: Private taxi operators have more control of their fleet renewal than bus operators, so if an EV leasing mechanism could be organised, it would be very effective.	Low feasibility: However, many taxis are operated by individuals either informally or through ride-sharing platforms, so this would be difficult to organise. The Government would also struggle to fund this EV leasing mechanism, so an external financier would be required.	Suitable only if taxi sector is formalised: This incentive could be effective in encouraging the adoption of EVs, but proving it will be used for a vehicle to be used as a taxi will be very hard unless the sector is much more formalised than it currently is.

		Charging-as-a-service model	Financial	Involves the taxi operators using charging services from subscribed charging service providers.	High initial capital cost of EVs: This model will help the operators avoiding the upfront cost required for setting up the charging infrastructure. Instead, they pay a regular subscription for the service, helping to make the payments more manageable.	High effectiveness It would make potentially prohibitive charging installation costs much more manageable.	Low feasibility: It would be difficult to connect charging-as-a-service providers to taxi operators, given the fragmented and informal nature of the market.	Suitable only if taxi sector is formalised: This incentive could be effective in encouraging the adoption of EVs, but proving it will be used for a vehicle to be used as a taxi will be very hard unless the sector is much more formalised than it currently is.
		Access to bus lanes for EVs	Non-financial	Through number plate recognition, electric taxis allowed in bus lanes to bypass traffic.	High initial capital cost of EVs Range anxiety Although it doesn't directly address the issue, it may make the high initial capital cost of EVs more palatable if the higher cost comes with the ability to bypass traffic. However, many bus lanes are already frequently used by private cars/taxis which are not allowed in them. It would also reduce the attractiveness of buses for the routes where bus lanes are enforced (e.g. Peace Avenue).	Low effectiveness: If taxis were allowed in bus lanes, too many vehicles would be in the bus lanes for this to be an incentive, and buses would be significantly hampered.	Medium feasibility/low acceptability: This could be achieved through number plate recognition camera enforcement. However, enforcement of bus lanes is already weak in UB. MUB and MRTD are against this proposal.	Not suitable: Even if the sector is formalised, there are too many taxis in operation in UB for this to be feasible. It would be very detrimental to the operation of buses.

		Parking benefits for EVs	Non-financial	Through number plate recognition, EVs allowed to park for free/at reduced costs/in EV-only spaces.	High initial capital cost of EVs Range anxiety Although it doesn't directly address the issue, it may make the high initial capital cost of EVs more palatable if the higher cost comes with the ability to park more easily/cheaply in the city. This could provide operational benefits if electric taxi spaces were located near main trip attractors.	Moderate effectiveness: Similar to using bus lanes, the volume of taxis able to benefit from this incentive may nullify it.	High feasibility: This could be introduced very feasibly. It would only require markings to denote EV spaces and enforcement either from parking attendants or cameras.	Suitable: Even if the sector is formalised, there are too many taxis in operation in UB for this to be feasible. It would negate the incentive for private vehicle owners.
		Introduction of Contract/Licence Benefits for PT EV Operators	Non-financial	For taxis, this could be reduced licensing fees for companies with an EV fleet.	Moderate market readiness: Whilst licensing fees currently only apply to a small proportion of the existing taxi fleet, as most taxis are not licensed by the MUB PTD, they could help the sector transition to EVs if it became more formalised. Private entities may struggle to source EVs independently, but assistance in procurement through MUB PTD contacts could aid this process.	Moderate-high effectiveness: Depending on the cost of taxi licenses, the discount applied and the threshold of EVs required to qualify for the reduced licence fee, this could save operators a substantial amount on their operational costs.	Moderate-high feasibility: This is very dependent upon the formalisation of the taxi sector, which would require enforcing licensing requirements for private operators. This will be a difficult process, but once the majority of taxi operators are licensed, it would be relatively easy to apply a discount based on the number of EVs registered with the operator.	Suitable only if taxi sector is formalised: This incentive could be effective in encouraging the adoption of EVs, but formalising the sector will be a difficult process.

		Exemption of Annual Vehicle Registration Charges on EVs	Financial	Similar to the tax exemption. Could be applied in the short term. Could be a reduction rather than exemption. Depending on the cost of vehicle registration, may be more symbolic than a strong monetary incentive (makes up a small portion of TCO).	High initial capital cost of EVs: This would make EVs slightly more price competitive compared to ICEVs.	Low effectiveness: One of the main barriers to EV adoption for taxi operators is the much higher capital cost of EVs. Vehicle registration costs are insignificant in comparison to the difference in capital costs, so this would not provide much of an incentive to switch to EVs.	High feasibility: The annual vehicle registration charge could be easily repealed for EVs.	Not suitable: Even if the sector is formalised, the level of incentive provided would not be worth the loss of revenue.
		EV only-restriction at EV charging spaces	Non-financial	Mandate for free parking for up to X hours at EV charging station spaces in public car parks (while charging).	High initial capital cost of EVs: This would make EVs very slightly more price competitive compared to ICEVs. Range anxiety: Being able to access chargers with more confidence in the city would reduce range anxiety.	Low-moderate effectiveness: Parking costs make up a small portion of TCO for taxis. Exemption from parking charges would not be much of an incentive for taxi operators. The confidence to be able to find a charging space when required would be improved. This would provide a moderate incentive to taxi operators.	Low feasibility: Whilst this could be easily enforced either by parking attendants or cameras, if taxis were permitted to charge at parking spaces, it is likely those chargers would be occupied by taxis a large proportion of the time.	Not suitable: If taxis are allowed to charge at public charging stations, it's likely that it would make them redundant for most private users.

		EV Charger Subsidy	Financial	A captive EV charging station is a charging station that is owned and operated by a private entity, such as a business, apartment complex, or government agency. These stations are typically only accessible to the people who own or lease property from the entity that owns the station. A capital subsidy provided by a third party to these private entities could alleviate some of the upfront capital burden cost of charging facilities. The subsidy may stipulate conditions, such as charger specification requirements or RES generation, and provide advice on charging equipment and installation.	High initial capital cost of EVs: The capital cost of chargers and their installation is a significant portion of the cost of EV fleet transition. This is also an area that is less well understood by operators, so advice/requirements could provide them with guidance to encourage a transition to EVs. Range anxiety: Being able to access chargers with more confidence in the city would reduce range anxiety.	High effectiveness: This would help to manage the higher initial upfront costs of EVs. It would also help taxi companies to reduce concerns over range anxiety, enabling them to develop an effective charging network. They could manage the usage of this charging network, and this would also free up public chargers for private users.	Low-moderate feasibility: The financial burden of this subsidy would be much less than a subsidy for vehicles. However, it would still require significant funds, depending on the level of subsidy required. However, distributing the subsidy beyond the existing taxi companies would be difficult in the short-term, with most operators being individuals who wouldn't benefit from such a captive charging network.	Suitable only if taxi sector is formalised: This incentive could be effective in encouraging the adoption of EVs, but it requires most operators to belong to a taxi company rather than operating as individuals.

		EURO V Fuel Standard	Non-financial	Euro V fuel standards set a maximum sulphur content of 10ppm in petroleum fuel, which limits the PM emissions from ICEVs. This is good for the air quality of UB but it will mean the price of petroleum fuel is likely to rise slightly. Whilst not a reason to introduce the EURO V fuel standard in itself, it will raise the TCO of ICEVs, making them more comparable with EVs.	Moderate-high TCO differential: The slightly higher fuel price for ICEVs will bring their TCO closer to EVs. It will also help to make the residual ICEVS (still the majority of automobiles in UB) less harmful to air quality.	Low-moderate effectiveness: The equalising effect of the TCOs would be fairly small – the key issue would still be upfront capital cost.	High acceptability/moderate feasibility: MOET already has the ambition of EURO V fuel by 2030. Mongolia’s heavy reliance on one supplier may be an issue in guaranteeing EURO V fuel, but a large proportion of fuel imported is already EURO V.	Suitable: Whilst the case for introducing EURO V fuel standards for the purpose of incentivising e-mobility may not be enough on its own, the EURO V standard is already planned to be brought in and should be implemented mainly for its air quality benefits. The co-benefits for EVs are a bonus.

Light freight (new)	Moderate-low supply of electric vehicles in South Korea & China, although proportion of sales increasing rapidly in both countries (27% and 15% of sales in 2022, respectively) Higher initial capital cost of EVs Range anxiety	Reduction of Taxation on private EVs	Financial	Customs tax and/or VAT and/or road tax reduction can be applied to EVs. Often these reductions are generous to begin with and gradually reduce to the same as ICEVs as EVs become more popular/affordable.	Higher initial capital cost of EVs: This makes EV more price competitive compared to ICEVs (making up for their typically higher initial capital cost). EVs already benefit from the lowest customs tax band. However, other import costs, such as transportation and customs duties in other countries, and a higher vehicle cost on average contribute to EVs' higher TCO than ICEVs.	Low-moderate effectiveness: EVs already benefit from reduced excise duty taxation. As customs and import taxes are applied to the vehicle value and are already relatively low (5% and 10% respectively), any reductions in these taxes would not make much difference to the initial costs of purchasing EVs. Reduction in road tax would not make much difference to the overall TCO, which is already comparable between EVs and ICEVs for light freight.	High feasibility: Excise duties for EVs are already differentiated from ICEVs and most HEVs. As customs taxes and VAT are not differentiated by engine type and age, it would be slightly more complicated to introduce EV-only rates, but this would be very feasible.	Not suitable: Even the removal of import taxes would not make EVs price competitive with HEVs and ICEVs. Similarly, reduction or removal of road taxes would not be enough of an incentive for this segment.
		Capital Subsidy on Purchase of EVs	Financial	Capital grant to reduce the cost of purchase of EVs. Often only applies to EV operators. This can be limited programmatic intervention with gradually reducing subsidies and capped to a specific number of EVs. The subsidy could be extended only to EVs meeting 1) advance battery chemistries 2) defined quality and safety standards 3) defined localisation and other set parameters. This subsidy can be linked to EVs' performance, measured in terms of battery capacity (kWh), as this is the primary contributing factor to EVs' higher cost. It can be gradually phased-out as EV reaches ICE price parity.	High initial capital cost of EVs: This would make them more price competitive compared to ICEVs (making up for their typically higher initial capital cost).	High effectiveness: Freight businesses have control over their fleet procurement, so a capital subsidy would help to manage the initial capital costs of EVs.	Low feasibility/acceptability: The Government would not be able to afford the level of subsidy required to make this incentive effective.	Not suitable: Whilst this would be an effective incentive to increase the affordability of EVs, it would be too expensive for the Government to implement.

		Introduction of Battery Leasing Mechanisms for EVs	Financial	The cost of EV battery is separated out from the cost of the rest of the vehicle for the operator. The operator funds the cost of the rest of the vehicle upfront, whilst a third party bears the capital cost of the battery and then leases the battery to the operator. The operator incrementally pays the third party for the cost of the battery over time, making the payment more manageable for the operator.	High initial capital cost of EVs: This would substantially reduce the initial capital burden on operators, as a substantial portion of an EV cost lies in the battery. Although it would slightly increase the TCO, operators would find managing the expenditure more feasible if the battery cost was converted to OPEX from CAPEX.	High effectiveness: Freight businesses have control over their fleet procurement, so a battery leasing mechanism would significantly help to manage the initial capital costs.	Low feasibility/acceptability: It may be difficult to separate out the battery cost from the vehicle cost. Stakeholder engagement suggested this incentive was not seen as acceptable.	Not suitable: This would be a difficult incentive to introduce in practice, and one that is not seen favourably by stakeholders.
		Encouraging Banks to Finance EVs	Financial	Given the nascency of PT EV technology and its adoption, Financial Institutions (FIs) such as banks and NBFCs are not lending to EVs due to associated asset (e.g., technology, resale, manufacturer, etc.) and business model (operation and maintenance, utilisation, etc.) risks. FIs see a high risk from the EV sector. These risks are both real (e.g., uncertainty of resale value) and perceived (e.g., product quality). Higher capital costs for EVs require purchasers to borrow greater amounts, creating challenges both in terms of securing the financing (risk) and the feasibility of the financing costs. Commercial private sector rates in Mongolia (in MNT) are approximately 18% for used buses, making long-term financing for EVs unviable for many companies. Various mechanisms can be used to support banks and non-banking finance companies (NBFCs) to finance EVs to ease and lower cost of financing EVs. It can be achieved, in addition to the concessional financing already offered through the Mongolian Green Finance Corporation, through setting up a guarantee fund to reduce the risk of loans for operators.	High initial capital cost of EVs: The encouragement of FIs and NBFCs through incentives and attractive financing options should help freight operators pay for EVs by reducing the initial capital burden and making the cost of the vehicle more manageable for owners. Private investment is likely to remain a more expensive financing mechanism to public investment (even with incentives), and so will increase TCO relative to BAU. However, with appropriate risk apportionment it can reduce the TCO relative purely private investment.	Moderate-high effectiveness: It would reduce the borrowing requirement for taxi operators, which is one of the key barriers to further adoption of EVs. This view was shared by key stakeholders at a workshop discussing potential incentives for e-mobility adoption.	Moderate-high feasibility: If climate financing could be used as a source for a guarantee fund for low interest investments, this would significantly limit the financial risks for the Government. Stakeholder engagement suggested this would be an acceptable incentive.	Suitable: Although some public financial backing would be required to guarantee private loans, it would not be as expensive as funding subsidies and loans directly.

		EV/Public leasing model	Financial	The EVs are availed on lease by the operators based on contract/agreement, either directly with a manufacturer or through a third-party financing organisation.	High initial capital cost of EVs: This model helps to address the upfront financing issues for the operators by converting CAPEX costs to OPEX costs.	High effectiveness: Private freight operators have full control of their fleet renewal, so this would be an attractive incentive for them.	Low-moderate feasibility: The light freight industry is largely private, so new contracts would have to be drawn up to facilitate the conditions of the EV leasing. An independent FI may also be required to provide the financing for such a scheme.	Suitable: If an independent FI can be found to provide funding for a subsidy, it could persuade freight operators to purchase EVs. However, it may take time to find an independent FI willing to do this. Therefore, it is a low priority incentive.
		Charging-as-a-service model	Financial	Involves the fleet operators using charging services from subscribed charging service providers.	High initial capital cost of EVs: This model will help the operators avoiding the upfront cost required for setting up the charging infrastructure. Instead, they pay a regular subscription for the service, helping to make the payments more manageable. Range anxiety: The charging services able to be provided at the start of freight operators' EV adoption may help to alleviate range anxiety.	High effectiveness: It would make potentially prohibitive charging installation costs much more manageable.	High feasibility/acceptability: Charging-as-a-service providers exist and would likely be interested in the Mongolian market, if given clarity on the scale of charging services required and ability to guarantee payments. Deemed acceptable by stakeholders.	Highly suitable: Although not necessary to facilitate the electrification of light freight fleets, it could provide important financial support and reduce range anxiety.

		Access to bus lanes for EVs	Non-financial	Through number plate recognition, electric taxis allowed in bus lanes to bypass traffic.	High initial capital cost of EVs Range anxiety Although it doesn't directly address the issue, it may make the high initial capital cost of EVs more palatable if the higher cost comes with the ability to bypass traffic. However, many bus lanes are already frequently used by vehicles which are not allowed in them. It would also reduce the attractiveness of buses for the routes where bus lanes are enforced (e.g. Peace Avenue).	Low effectiveness: If light freight were allowed in bus lanes, too many vehicles would be in the bus lanes for this to be an incentive, and buses would be significantly hampered.	Medium feasibility: This could be achieved through number plate recognition camera enforcement. However, enforcement of bus lanes is already weak in UB.	Not suitable: Even if the sector is formalised, there are too many light freight vehicles in operation in UB for this to be feasible. It would be very detrimental to the operation of buses.
		Free/reduced-fee/EV-only parking for EVs	Non-financial	Through number plate recognition, EVs allowed to park for free/at reduced costs/in EV-only spaces.	High initial capital cost of EVs Range anxiety Although it doesn't directly address the issue, it may make the high initial capital cost of EVs more palatable if the higher cost comes with the ability to park more easily/cheaply in the city. This could provide operational benefits if electric light freight spaces were located near delivery hubs / loading bays.	Low effectiveness: Parking costs make up a small portion of TCO for light freight operators. Exemption from parking charges would not be much of an incentive.	Low-moderate feasibility: These charging spaces would need to be located in freight areas which are not in high demand by the public (e.g. near depots, loading bays). These areas may not be on public land.	Not suitable: Locating the spaces would be difficult. These problems are better addressed through captive charging incentives.

		Exemption of Annual Vehicle Registration Charges on EVs	Financial	Similar to the tax exemption. Could be applied in the short term. Could be a reduction rather than exemption. Depending on the cost of vehicle registration, may be more symbolic than a strong monetary incentive (makes up a small portion of TCO).	High initial capital cost of EVs: This would make EVs slightly more price competitive compared to ICEVs.	Low effectiveness: One of the main barriers to EV adoption for light freight operators is the much higher capital cost of EVs. Vehicle registration costs are insignificant in comparison to the difference in capital costs, so this would not provide much of an incentive to switch to EVs.	High feasibility: The annual vehicle registration charge could be easily repealed for EVs.	Not suitable: The level of incentive provided would not be worth the loss of revenue.
		EV only-restriction at EV charging spaces	Non-financial	Mandate for free parking for up to X hours at EV charging station spaces in public car parks (while charging).	High initial capital cost of EVs: This would make EVs very slightly more price competitive compared to ICEVs. Range anxiety: Being able to access chargers with more confidence in the city would reduce range anxiety.	Low-moderate effectiveness: Parking costs make up a small portion of TCO for light freight operators. Exemption from parking charges would not be much of an incentive. The confidence to be able to find a charging space when required would be improved. This would provide a moderate incentive to light freight operators.	Low feasibility: Whilst this could be easily enforced either by parking attendants or cameras, these spaces would need to be located away from areas of high public parking demand. Public land in these areas may be limited.	Not suitable: Locating the spaces would be difficult. These problems are better addressed through captive charging incentives.

		EV Charger Subsidy	Financial	A captive EV charging station is a charging station that is owned and operated by a private entity, such as a business, apartment complex, or government agency. These stations are typically only accessible to the people who own or lease property from the entity that owns the station. A capital subsidy provided by a third party to these private entities could alleviate some of the upfront capital burden cost of charging facilities. The subsidy may stipulate conditions, such as charger specification requirements or RES generation, and provide advice on charging equipment and installation.	High initial capital cost of EVs: The capital cost of chargers and their installation is a significant portion of the cost of EV fleet transition. This is also an area that is less well understood by operators, so advice/requirements could provide them with guidance to encourage a transition to EVs. Range anxiety: Being able to access chargers with more confidence in the city would reduce range anxiety.	High effectiveness: This would help to manage the higher initial upfront costs of EVs. It would also help light freight companies to reduce concerns over range anxiety, enabling them to develop an effective charging network. They could manage the usage of this charging network, and this would also free up public chargers for private users.	Moderate-high feasibility: The financial burden of this subsidy would be much less than a subsidy for vehicles. However, it would still require significant funds, depending on the level of subsidy required.	Suitable: This incentive could be effective in encouraging the adoption of EVs and is quite feasible.
		EURO V Fuel Standard	Non-financial	Euro V fuel standards set a maximum sulphur content of 10ppm in petroleum fuel, which limits the PM emissions from ICEVs. This is good for the air quality of UB but it will mean the price of petroleum fuel is likely to rise slightly. Whilst not a reason to introduce the EURO V fuel standard in itself, it will raise the TCO of ICEVs, making them more comparable with EVs.	Moderate-high TCO differential: The slightly higher fuel price for ICEVs will bring their TCO closer to EVs. It will also help to make the residual ICEVS (still the majority of automobiles in UB) less harmful to air quality.	Low-moderate effectiveness: The equalising effect of the TCOs would be fairly small – the key issue would still be upfront capital cost.	High acceptability/moderate feasibility: MOET already has the ambition of EURO V fuel by 2030. Mongolia's heavy reliance on one supplier may be an issue in guaranteeing EURO V fuel, but a large proportion of fuel imported is already EURO V.	Suitable: Whilst the case for introducing EURO V fuel standards for the purpose of incentivising e-mobility may not be enough on its own, the EURO V standard is already planned to be brought in and should be implemented mainly for its air quality benefits. The co-benefits for EVs are a bonus.

		Mandate for Citizens to be Able to Request that Public and Commercial Car Parking Spaces be Restricted to EVs/EV Charging Stations Installed	Non-financial	Give citizens the right to request EV-only parking spaces and/or public EV chargers at public car parks (including on-street parking). This would help to ensure parking spaces and chargers are prioritised where demand is highest. It could be facilitated through an online tool or app.	Range anxiety: Cold conditions will mean significantly reduced ranges, and opportunity charging away from home during the day will be needed along with the assurance of parking spaces, particularly during early adoption. Drivers will need re-assuring that they will be able to park and charge during the day, especially in the short- to medium-term.	High effectiveness: This would help to target EV charging stations and parking spaces to demand.	Moderate-high feasibility: This would ideally be a technology-enabled solution, which could be helped by the private sector. Or it could be a low-tech solution. Providing & enforcing EV-only spaces would be relatively simple. Providing EV public chargers would be more expensive, but there are already public chargers in UB.	Highly suitable: This is a reasonably simple solution that will help to target chargers and parking spaces more effectively to demand.
		Right to Install EV Chargers in Communal Residential Parking Lots	Non-financial	Give citizens living in apartment blocks and other residences with communal parking lots the right to install home chargers in their shared parking facilities. Many of UB’s citizens live in apartments. Not all apartments have communal parking lots for their residents, but this will help a substantial proportion of the population.	Range anxiety: Cold conditions will mean significantly reduced ranges, and home charging will be needed to ensure affordable charging, as well as the opportunity for cold climate mitigation measures such as pre-heating.	High effectiveness: A key barrier for many of UB’s citizens to EVs will be the inability to charge at their home. Affording a home charge may not be easy, but subsidies and financing could help with this. A good initial step is the ability to install a charger in the first place.	High feasibility: This would take some planning legislation. There would need to be an assessment of the grid impact of each application.	Highly suitable: For EVs to be affordable and practical, citizens need to have the right to be able to charge at home. This provides the foundations for that to be possible for many.

Selected Incentives

11.58 Between the different target segments, 13 incentives have been found to be suitable to varying degrees in Mongolia. These are shown in Table A-15.

Table A-15: Summary of incentives recommended for Mongolia

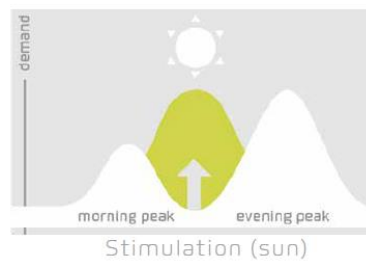
Vehicle segment	Level of suitability	Incentive	ID
Private Automobile (mass market)	Highly suitable	Mandate for Citizens to be Able to Request that Public and Commercial Car Parking Spaces be Restricted to EVs/EV Charging Stations Installed	D1
		Right to Install EV Chargers in Communal Residential Parking Lots	D2
		Alignment of Taxation on private EVs	D10
	Suitable	EV only-restriction at EV charging spaces	D6
		EV Charger Subsidy	D7
		Encouraging Banks to Finance EVs	D6
		EURO V Fuel Standard	D4
	Suitable with specific conditions	Reduced fee parking for EVs	D9
Light Freight	Highly suitable	Charging-as-a-service model	D5
		Mandate for Citizens to be Able to Request that Public and Commercial Car Parking Spaces be Restricted to EVs/EV Charging Stations Installed	D1
		Right to Install EV Chargers in Communal Residential Parking Lots	D2
	Suitable	Encouraging Banks to Finance EVs	D6
		EV-Only Restriction at EV Charging Spaces	D8
		EV leasing model	D11
		EV Charger Subsidy	D7

Taxi (mass market)	Suitable	Encouraging Banks to Finance (PT) EVs	D6
		Reduced parking fees for EVs	D9
		EURO V Fuel Standard	D4
	Suitable with specific conditions	Introduction of Battery Leasing Mechanisms	D12
		EV leasing model	D11
		Charging-as-a-service model	D5
		Reduced licence fee for taxi operators	D13
		EV Charger Subsidy	D7
Urban buses (12m)	Highly suitable	Charging-as-a-service model	D5
		E-Bus Only Corridors	D3
	Suitable	EV Charger Subsidy	D7
		EURO V Fuel Standard	D4
	Suitable with specific conditions	EV leasing model	D11

Appendix B: Smart Charging Methods for Distributing Demand



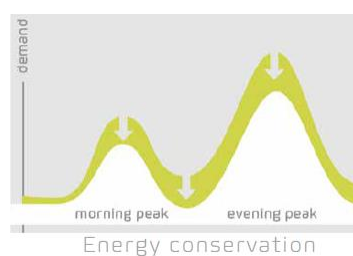
Valley Filling: This involves increasing the charging rate or charging more vehicles during times of low energy demand, effectively 'filling' the valleys in the demand curve.



Stimulation: Charging is accelerated when there is an abundance of sustainable (or less expensive) electricity available, promoting the use of cleaner energy sources.



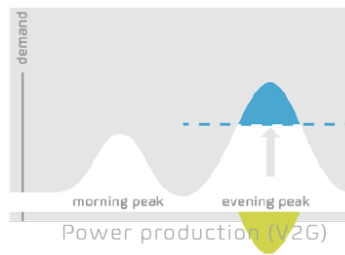
Load Shifting: Charging rates are reduced during peak demand periods to prevent grid overload. Conversely, EVs charge more quickly when demand is lower.



Energy Conservation: During charging sessions, the charging speed is intentionally kept below the technical maximum for the entire duration, conserving energy.



Peak Clipping/Peak Shaving: To avoid overloading the grid, charging is moderated during times when peak demand is likely.

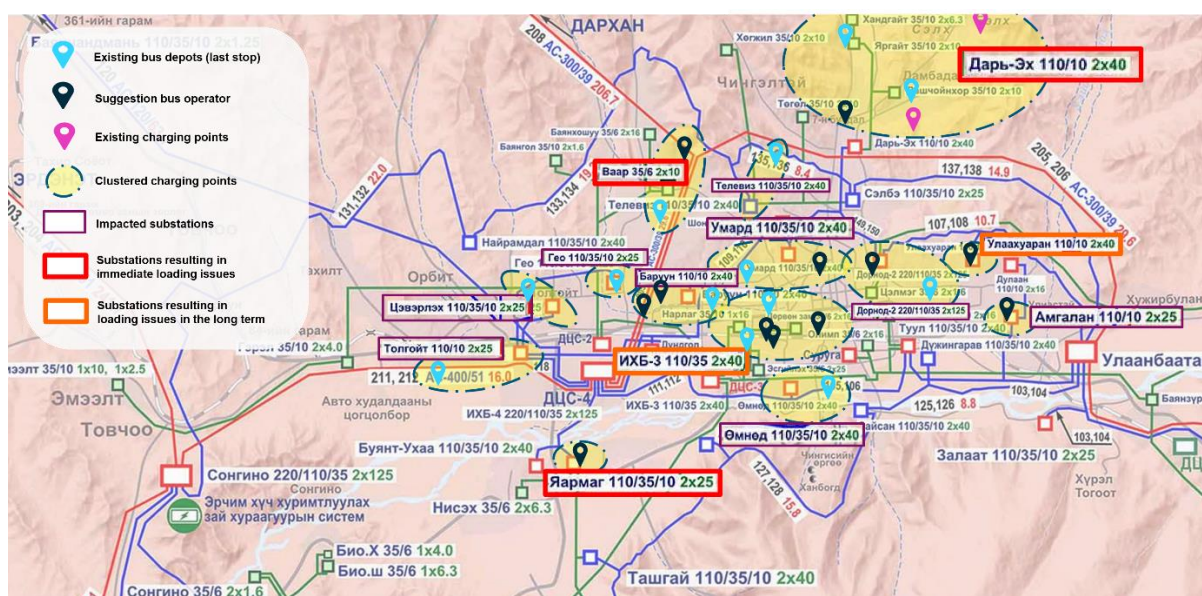


Power Production: EVs can contribute to the energy supply by returning power to the grid, a process known as vehicle-to-grid (V2G) technology.

Appendix C: Infrastructure Investment Costs for E-bus Upgrades

Figure C 1 below shows the e-bus charging points proposed by MUB, and the 14 substations to which they would connect.

Figure C 1: Proposed e-bus charging sites and impacted distribution substations¹⁹¹



- 11.59 Taking the above into consideration, our financial impact analyses indicate that USD 21.6 million are to be reserved on the short-term (2025-20230) for electrical infrastructure upgrades¹⁹² to cater for future load demand. On the longer term (2030-2050) an additional USD 32.9 million is required.

Short term investments (2024 – 2030)	Long term investments (2030-2050)
21.6 million USD	32.9 million USD

- 11.60 On the short term, the following substations are impacted due to substation loading going above threshold levels of 70-80%:

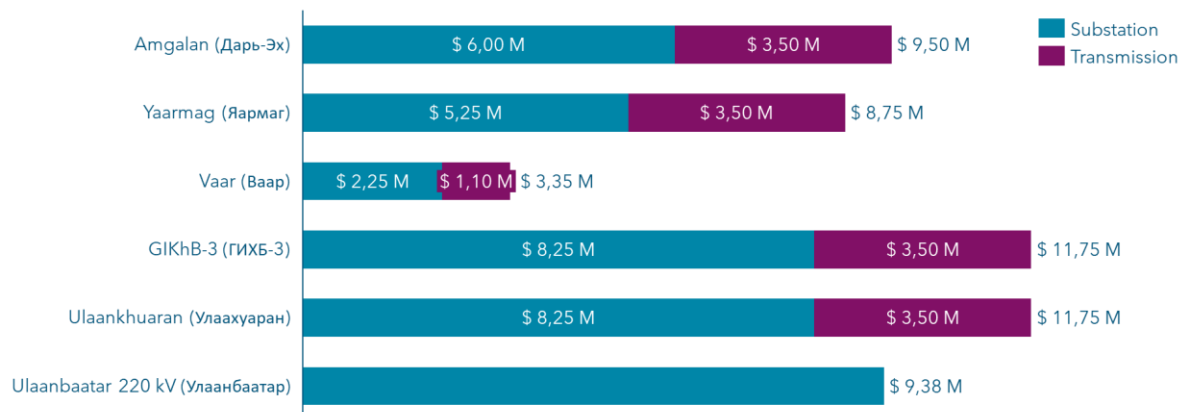
- Амгалан (Дарь-Эх)

¹⁹¹ Directly impacted substations: Амгалан, ГЛХБ-3, Баруун, Дорнод-2, Умард, Ваар, Дарь-Эх, Төвөлз, Улаанхуаран, Гёе, Тсөвөрлөх, Толгойт, Өмнөд, Яармаг; Impacted substations upstream: Улаанбаатар, Онгон, ИХБ4

¹⁹² The substations are assumed to be aging with a loading above 80% to trigger the need for upgrade. The investment figures consider doubling the substation existing capacity. Based on USD 525k per 10 MVA, 10% design and tendering, 10% installation and commissioning. Transmission lines between substations are averaged at 10 km per impacted point and USD 110 kV

- Yaarmag (Яармаг)
 - Vaar (Ваар)
- 11.61 These are primarily due to the large number of charging locations and an already high loading of the substations.
- 11.62 On the long term, there are two substations that will most likely receive high loading issue on the long-term considering other growth. These stations have a loading of 65% after e-bus implementation:
- GIKhB-3 (ГИХБ-3)
 - Ulaankhуaran (Улаахуаран)
- 11.63 Additionally, assuming all charging points are implemented this will also has consequences for the upstream 220 kV system supplying Ulaanbaatar. The most impacted substations are IHB-4 and Ulaanbaatar. However, Ulaanbaatar substation is already highly loaded reaching 75% after a complete E-bus rollout. Collectively, this long-term impact will result in an infrastructure investment of USD 32,9 million. A breakdown the infrastructure investments are given in Figure C 2.

Figure C 2: Breakdown of grid investments due to E-bus deployment in Ulaanbaatar



Appendix D: Charging point planning and management

Figure D 1: EV Charger Mapping in Apeldoorn, Netherlands using RHDHV's VOLT tool

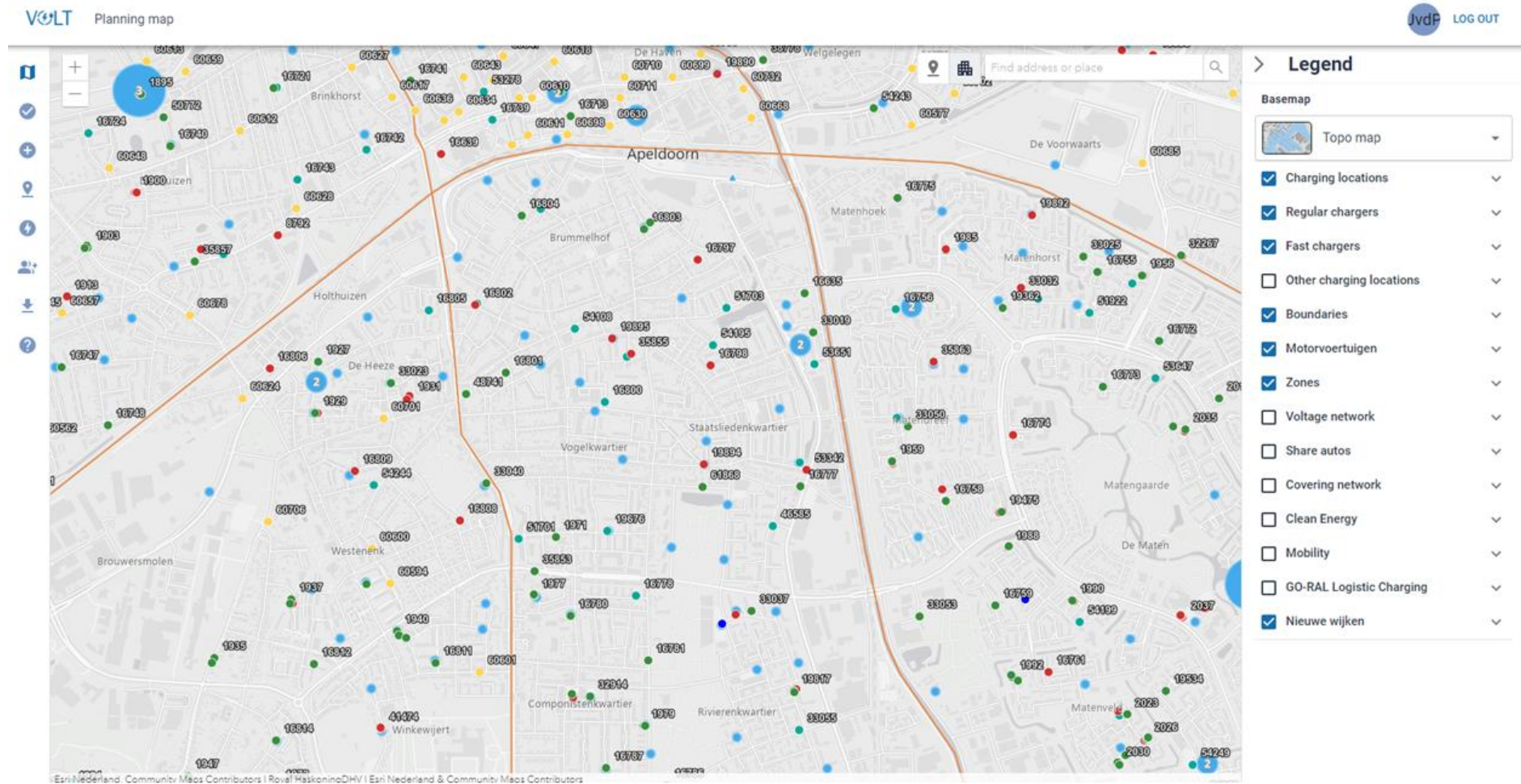


Figure D 2: EV Charger Request Status in Apeldoorn, Netherlands using RHDHV's VOLT tool

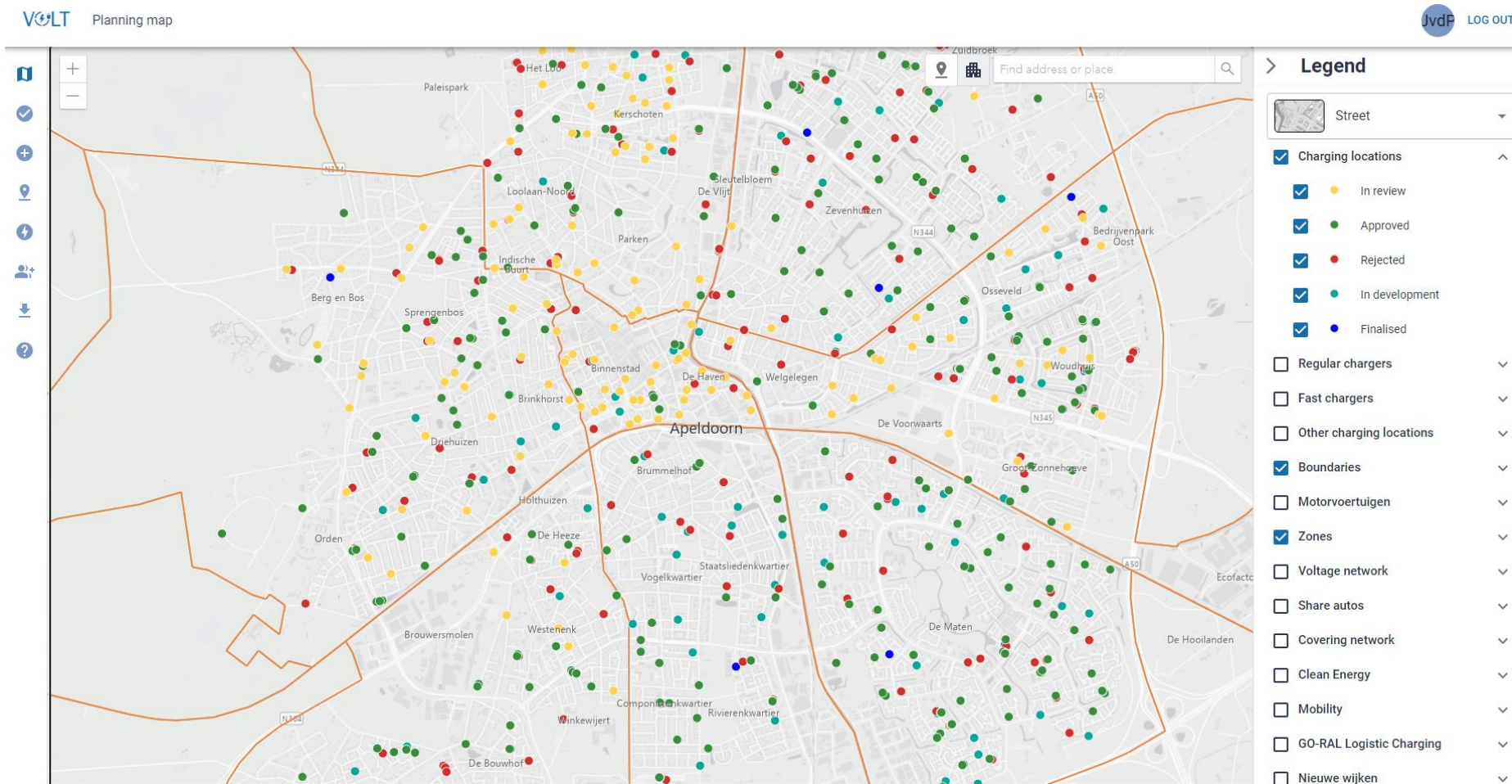
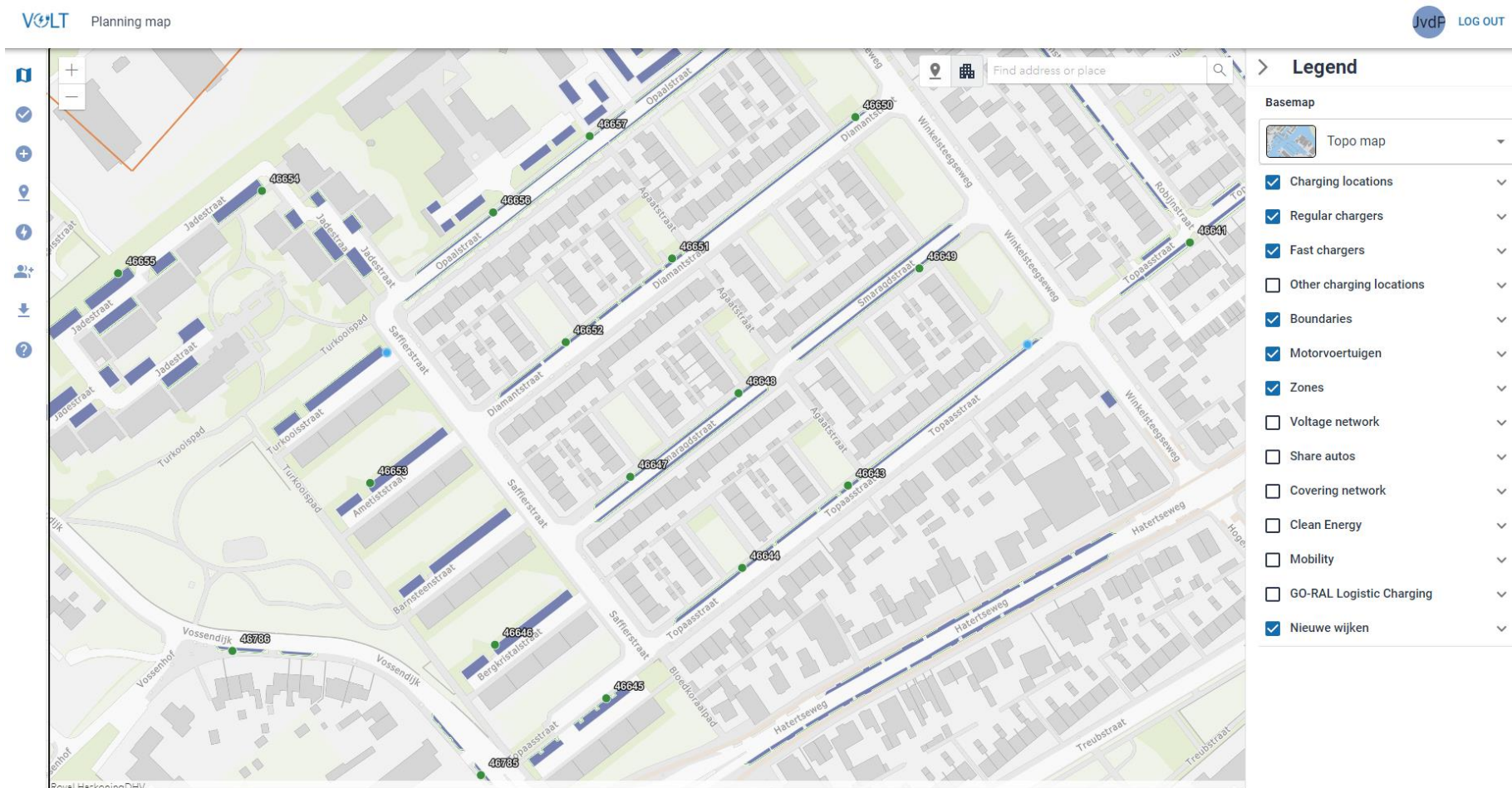


Figure D 3: Street Level EV Charger Map from Apeldoorn, Netherlands using RHDHV's VOLT tool



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