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SITUATION ANALYSIS AND PRELIMINARY MARKET STUDY FOR ADVANCING E-BUS SYSTEMS:

CASE STUDIES OF EGYPT, JORDAN, AND MOROCCO

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EXECUTIVE SUMMARY

This report presents a global overview of the status of electric mobility industry with a focus on bus systems – among developments that are relevant to the growing economies of the global south. An effort has been made to specifically present an extensive situation analysis and market overview for the Egypt and Jordan markets. The report also presents the case study of Morocco, though in limited depth. The objective is to explore opportunities for cooperation and investment in advancing e-mobility in the target countries, and to identify the needs and address the barriers.

The research is conducted building on the guidance provided by the *Sustainable Mobility for All (SuM4All)* Working Group on Electric mobility in 2020 under the leadership of the group co-chairs Transformative Urban Mobility Initiative (TUMI) and International Association of Public Transport (UITP) and building on an extensive process of stakeholder consultations and interviews and expert analysis in Egypt.

GLOBAL OVERVIEW

The key highlights of global developments of relevance are as follows:

- The **global market** for electric buses, and EVs in general, is rapidly expanding, but **subsidies** are still largely required by way of various support schemes and interventions to compete with conventional Internal Combustions Engine (ICE) buses.
- In the Middle East and North Africa **region**, particularly in Egypt and Morocco, the experience has been mostly limited to **piloting projects** of 6-month trials with a fleet that could vary anywhere between one or two buses to a maximum of 15. Such projects are typically cornered by Chinese OEMs and mostly involve fully-electric buses.
- Estimates suggest global stocks of e-buses exceed **500,000.** About **98 percent of this is in China,** which is also leading in manufacturing these vehicles. The number is growing rapidly in other countries and regions as well, most prominently in Chile and parts of Europe. The presence of Chinese OEMs is accordingly disproportionately high in developing countries that are initiating the adoption of EVs.
- Even though the *Total Cost of Ownership (TCO)* of electric vehicles is far from parity vis-à-vis conventional buses without market interventions, yet the **gap is closing substantially**. This is happening due to tightened **emission standards** set for conventional ICE buses, which means higher costs, along with

'**polluter-pays' measures,** on the one hand. On the other, continuously **declining battery costs** with right-sizing of batteries and economies of scale is promising steady reduction in prices of electric buses. Yet, support and incentives are generally still necessary in most contexts for the foreseeable future.

- **Clear country- and city-level targets,** be it for diesel reduction or e-mobility promotion, incentivize and encourage adoption and give encouraging signals to the industry and investors. Global experiences repeatedly assert that *political will* is critical.

- Common challenges in rolling out electric buses in existing fleets are still mostly associated with **high upfront costs,** which can be up to double or more of the conventional buses. Additionally, there are concerns about **infrastructure** and power requirements, along with the lack of sufficient **local know-how** to address such challenges and the competences to draw up the necessary studies required, such as grid-impact assessments for EV ramp-up, charging-strategy studies, scenario analysis, developing adequate locally-tailored business models, among others. Demonstrational projects are however gradually accelerating the learning curve in many countries.

- The trends in the *global south* point towards some **common themes** of development in the bus system network -- formalization of the **informal transport services**, consolidation of transport service operators into larger companies, bus-systems expansions and upgrades, phasing out of **subsidies**, and gradual efforts in **intermodal integration**.

- Compared to the more complex conventional mixed-traffic bus systems diffused into the urban fabric of cities, **Bus Rapid Transit (BRT)** is specifically receiving much attention. It is seen as a relatively superior option, while being often cheaper than other modes of collective transport such as rail-based systems. In either case, BRT or bus systems in mixed traffic, the market is expanding in emerging economies. Development agencies and leading think tanks have advocated this substantially.
- A number of developments on policy front have helped. E-mobility targets, **diesel phase-out targets**, improving emission control criteria as well as rising interest in **city-level schemes** such as low-emission-zones (LEZs) or promotion of various micro-mobility options, are all developments that have made way for faster adoption of EVs over conventional ICE vehicles. Clearly, a blend of policy and **accompanying measures, including those proposed,** are critical in assessing the local context, which varies considerably among countries and even cities.

EGYPT CASE STUDY

An in-depth analysis and preliminary market study of Egypt is summarized in the following highlights:

- **Egypt** is amongst the earliest countries worldwide to adopt electric rail transport (tramlines) but on-road e-mobility is still at an early stage, reflected in the ad hoc adoption of electric cars and a recent gradual introduction of electric buses. Fewer than 20 such electric buses are in operation across the country. The government's interest in rolling out electric buses is however high. But this interest is yet to be translated into coherent strategies and sufficient enabling policies and regulations.
- There are approximately **160,000 buses in Egypt licensed** in the categories of Public, Private, Tourist, Travel, or School transport, according to the nomenclature followed by the statistics authority. Of these, **10 percent are dedicated to public transport,** half of which are in Greater Cairo Metropolitan area with about 8,000 in regular intensive operation. The market is poised for steady growth with a compounded

> Among the identified objectives is increasing the market share of EVs in Egypt to 36 percent by 2030. The national strategy has been developed on the back of sufficient supportive studies, and it clearly indicates that gradual localization of manufacturing/assembling is the key motivation

annual growth rate of 4 percent over 2014-2019. The political will to pursue cleaner bus fleets – CNG in the short term and electric buses in the long run – in addition to the replacement needs are reasons for this optimism.

- With substantial recent additions to the power production capacities and limited corresponding growth in electricity demand, there is substantial **extra capacity of power production**, which augurs well for all forms of electrified transport. Furthermore, rapid increase in renewable energy shares and cleaner forms of conventional power are together **reducing the grid emission factor**, and accordingly lowering the carbon footprint of electrification in transport.

- **Relatively cheaper fuels that were** previously highly subsidized are also in the process of liberalization, gradually making conventional vehicles operation more expensive. The **subsidy phaseouts** are a significant nudge towards a shift to electric mobility. Additionally, **diesel fuel** contains **high sulphur levels to date (exceeding 2,500ppm),** implying even greater urgency to accelerate the shift away from diesel fuel.

- **Smaller-sized alternatives to buses are finding adoption in many local urban contexts, particularly dense informal settlements that require such vehicles. Here, with three-wheelers that are regarded as a nuisance while regular buses found to** be too large for many narrow streets, a move towards **9-seat vans** is becoming a plausible alternative. These are being gradually advocated by the government, announcing phase-out of three-wheelers and to replacing them with vans.

- Various studies have been dedicated to explore the potential of e-mobility in Egypt by development partners in cooperation with the government with several identified areas. But clear **ownership** of the topic is yet to be determined and is a limiting factor in the development of the sector.

- In 2020, a **National Strategy for Electric Vehicles** was developed by the **Ministry of Military Production (MoMP)** in a first attempt to develop a unified national vision. The brief strategy however specifically addresses developing a manufacturing industry in Egypt, specifically with partners in **China**. This comes in a follow-up of partnerships initiated in April 2019 during China's Belt and Road Forum. Among the identified objectives is **increasing the market share of EVs in Egypt to 36 percent by 2030**. The national strategy has been developed on the back of sufficient supportive studies, and it clearly indicates that gradual localization of manufacturing/assembling is the **key motivation**.

- The MoMP strategy aims to mobilize Egypt's aging **state-owned companies and military factories** to cater to EV and EVSE (Electric Vehicle Supply Equipment) manufacturing. According to the 2019 agreement between MoMP's factory *Harby-200* facilities and Chinese company **Foton,** it was decided to jointly produce fully electric buses, targeting 500 units per year with 45 percent local components. The aim was to produce 2,000 buses over four years. Efforts are also being made to likewise mobilize other state-owned facilities, such as the Ministry of Public Businesses, and the Arab Organization for Industrialization, for similar cooperation tie-ups with Chinese OEMs.

- The experience of rolling out electric buses in Egypt has been limited with the total stock smaller than 20. The following key cases have led to several lessons learnt:

    - **APTA:** In an effort started since 2016, the Alexandria Passenger Transport Authority (APTA) had planned to improve electrified transport, both by rehabilitating coaches by way of tramlines and procuring fully electric buses. During **2016-2019,** a lengthy process of trial and procurement in planning, budget approvals, a failed attempt for national tendering followed by an international tender resulted in the launch of **15 fully electric 12-meter buses from Chinese manufacturer BYD**. This was a purely bottom-up experience championed by the local authority. Key challenges in this rollout included the limited local competence and **limited enabling environment** at the national level to accelerate the process and plan for scalability. To enumerate, the tender had

to be repeated, exemption had to be sought on the original stiff **40 percent** custom duty that was granted after considerable effort, and the charging tariff was uncertain, among others. Clearly, the lack of a national strategy and plan limited the scalability and replicability of the project.

Secondly, the **BYD offer was about half the price** of the rest of the other seven bidders. As a result of the abnormally low price offered by BYD, a **misleading message got around to the executing authorities and stakeholders** about the upfront costs of electric buses and their competitiveness, delaying the learning process among the relevant government authorities. However, it also drew attention to the technology for the same reason. Scalability requires an extensive city-level study along with endorsement from the central government.

- **Mwasalat Misr**: A leading private operator of public bus fleets is Mwasalat Misr, operating more than **160** high-end city buses and minibuses in Greater Cairo and surrounding new settlements as a concessionaire for Cairo Transit Authority. In 2019, a well-planned pilot project, **'X-bus',** was launched to explore the potential of electric buses in Egypt jointly with Chinese company **Shanghai Wangxhiang Automobile Co Ltd**, part of CCI Holding Group. A **6-month trial** using overnight charging at 50kW power yielded good results. But due to the lack of an enabling national strategy, clients could not be secured under the project.

The pilot revealed general technical viability, but an uncertain level of cost competitiveness in terms of Total cost of ownership at the time. The bus was shipped back to China, but substantial in-house competence was developed in the process. The technical challenges noted in the 6-month trial were mostly minor.

Mwasalat Misr can be positioned as a high-readiness stakeholder for implementing fleet electrification projects **if three main issues are addressed:**

(a) Support in closing the gap in upfront costs,

(b) Certain and reliable charging infrastructure, tariffs, and relevant regulations.

(c) Customized Tenders to accommodate the specificities of electric vehicles by way of charging strategies and context-specific battery-sizing.

- The most significant push came in 2021 from a World Bank project in Egypt. As part of ***the Greater Cairo Air Pollution Management and Climate Change project (2021-2026,*** USD 40 million are allocated under the e-mobility transport component: *The Electric Buses Demo Project*. It includes procurement of **100 electric buses** and associated infrastructure, capacity-building together with the CTA as the component counterpart. Elsewhere minor trials of individual electric buses are planned for certain demonstrational use cases, including provision of a shuttle service between the airport and the flagship transport interchange hub of **Adly Mansour station**, and the flagship project in the **Giza pyramids plateau**. Neither would involve significant scale-up plans. The demonstrational and educational value however is notable.

- Barriers to scaling up electrification of bus fleets in Egypt are the generic to countries in early phases of the e-mobility adoption. These include clear ownership, strategy development needs, grid impact assessment, planning for charging strategies, relevant data availability, capacity development, and so on. There are also additional **country-specific issues**:

  *(a) The **low cost of diesel and CNG** fuels which challenge TCO-parity. In addition, **CNG's preeminent image as 'green' fuel** has led to substantial attention being diverted from EVs towards CNG. Natural gas should ideally be reserved for power production or petrochemicals.*

  *(b) The **low-cost buses procured locally** are sub-par due to limited specifications, more so in the case of diesel buses that use Euro-III engines at best. Most of the other manufacturing standards differ substantially from the export market, which also dents TCO-parity of EVs. The **lack of curbs on polluting vehicles** also undermines the competitive advantage of e-mobility.*

  *(c) There is limited **awareness about tools available for climate financing** and associated support among development partners, and even access to available means of support is insufficient.*

  *(d) **Space available** for stations or charging points in dense cities is limited, implying longer distances, or 'dead miles', to depots on the fringes of the large cities.*

  *(e) There is a lack of a **clear signal from the government about overall targets** for rolling out electric buses and associated infrastructure, indicating the need for assistance in strategy development. Even though targets for manufacturing have been announced, there is little indication of coordination among other sectors and public bodies of relevance, leaving out an opportunity for enhancing strategy development.*

- **Several measures are recommended to policy makers** and planners as detailed in the report. These address setting targets, adjusting the discourse, ensuring policy consistency and a fair playing field, especially for EVs. More specifically, there is a need to introduce safe emission standards and urban vehicle access regulations (UVARs) where needed, in addition to identifying clear roles and mandates for electric *buses*. Furthermore, it is necessary to focus on service requirements and standards of public transportation rather than technology choices to enable innovation in the private sector. Finally, for a constructive learning process, setting monitoring and evaluation programs for fleet renewal schemes – be it CNG, diesel, or electric

– is recommended and is an observed gap to date. Similarly, continuous evaluation of the target priority cities based on air pollution data is also necessary.

- **For multilateral development banks** and development partners in general, key areas of interest for cooperation and potential investment opportunities are suggested below for further investigation as well as necessary enabling activities.

    - **Electrification of public transport bus fleets in large cities may be catalyzed with phase-in targets**. Replacement of aging buses and expansion of bus fleets must focus on metropolitan areas of highest population – through APTA in **Alexandria and CTA in Greater Cairo** primarily – along with leading private sector operators. This requires in-depth city-level studies by way of grid impact assessment, charging strategy scenarios, operational and institutional requirements, evaluation of business models, full feasibility studies, among others. Air pollution data clearly indicates that Greater Cairo is a priority. There are other cities too that have not received similar attention in air pollution studies, but need to be assessed in future plans of the MoE to inform policy making. The population size and density are good criteria for identifying priority areas, such as Alexandria and the capital cities of other governorates, many of which have population exceeding a million. Fleet renewal and expansion promises substantial opportunity for penetration of new technologies. This can be phase-II of the "Go Green" program of the CNG promotion scheme.

    - The need to set up the required **charging infrastructure** in the target cities can't be overemphasized. For this, relevant *city-level* studies linking transport planning and charging needs need to be undertaken. For example, overnight charging for 1,000 buses, a fraction of Greater Cairo's bus needs, may require 50 MW of power or more. Even though overnight charging implies power demand in off-peak hours, the infrastructure would often need to be developed in dense cities with **legacy structures** and **limited space**. Hyperlocal in-depth studies are therefore necessary to explore a range of system-level solutions appropriate for each urban area in Egypt.

    - A quasi-demonstration **flagship project** could go a long way in garnering greater political support for the development of an entirely-electric public transport system in the **New Administrative Capital**. It would also be devoid of complexities of networks in old and densely populated cities and help develop local competences necessary for further developments in Egypt. The choice of a pollution-free area would further aid the strategic development of the sector and its subsequent ripple effect. Similarly, the choice of the new capital as a target for a **Low Emission Zone (LEZ)** area is under discussion.

    - **Efforts are also needed to build a whole ecosystem** for charging infrastructure development and planning for cleaner fuels and vehicles in general. This includes standards for conventional buses as well as planning for alternative **business models** and experience exchange. The specific **theme of advancing local manufacturing** is advisable to align with national priorities, while providing orientation on the various measures discussed herein to develop the enabling environment for gradual electrification of bus fleets. Furthermore, capacity building for fleet management systems and **data analytics** in transport planning can go a long way in assessing transport service requirements and improving system-level efficiency. Notably, the inclusion of the Ministry of Military Production and the Military Technical College is fundamental.

    - Although opportunities exist among private sector players, the fleets used in public transport in large cities remain the key recommended target for electrification due to their relatively high mileage and usage. This strengthens the case for switching to EVs in public transport on a sure footing. Nevertheless, potential involvement of private sector players with large bus fleets, or vans and other heavy- or medium-duty vehicles, are noted for potential services in the future, including FMCG fleets and mail services, among others.

JORDAN CASE STUDY

Based on an in-depth assessment of the e-mobility industry in Jordan and extensive stakeholder consultations, the highlights of the situation analysis and preliminary market study are summarized below:

- Jordan, with a population of 10.7 million inhabitants, is a significant potential market for electric vehicles. Much experience has been gained through the penetration of formerly incentivized light duty vehicles. But to date, the focus has been mostly on cars and their charging infrastructure, and less so on buses. The government however recognizes the importance of public transport, with emphasis on buses, as a necessary sustainability solution.

- Public transport is limited. There are 1.67 million vehicles in Jordan of which 1.1 million are private cars. Significantly, 59 percent of the population is unserved by public transport, and largely rely on private vehicles, mostly cars and motorcycles, for their mobility needs. About 24,000 electric cars are in circulation in 2021, while penetration of electric buses is in a much more nascent phase limited to trials/pilot projects in operation or in planning phases.

- An estimated 26,526 buses are in operation in Jordan, of which a third are public buses, mostly in the range of 7m to 12m buses. With numerous national and sub-national strategies addressing sustainable development and climate action, the government is aware and keen on ensuring a gradual mode shift from private vehicles towards public transport systems, whether buses in mixed traffic or in the form of the Bus Rapid Transit, which is already in progress.

- There are several national and subnational strategies in place advocating sustainable mobility, although not yet with the necessary depth that the topic necessitates. The effort until now has often focused on cars.

- Among the key challenges in promoting e-mobility is the uncertain legal and regulatory framework. The recent unexpected lifting of tax and customs incentives for electric cars is one such example, while there are no exemptions for electric buses, The limited ability to translate policies and action plans into actual sustainable and well-planned interventions is another serious limitation. This emphasized the need for further support as in many countries in a similar early stage.

  The Ministry of Energy and Mineral Resources (MEMR) and the Ministry of Transport have however recently formed an inter-ministerial committee on e-mobility in cooperation with other key stakeholders. It is currently leading the development of the e-mobility strategy under the umbrella of the updated Jordan Energy Strategy (JES) 2020-2030, which articulates e-mobility as a clear priority.

- Significant developments in the near future are also expected to kick in with a UNIDO-led project, the ***Integrated Adoption of Electric Mobility***. Financed by the Global Environmental Facility (GEF) and executed by the Global Green Growth Institute (GGGI, it is expected to start in late 2022 once approved. Among its objectives are preparing e-mobility demo projects and a financing facility, as well as providing support for policy and scale-up. The substantial several-fold co-financing by the government is a significant indicator of the political will to seriously invest in planning for e-mobility.

- Some of the important case studies with lessons learnt are discussed below:

  - **Amman and Zarqa Bus-Rapid Transit (BRT) System:** Two BRT corridor projects are planned, one in Amman, and the other between Amman and Zarqa . Although diesel-fueled buses are planned for the fleet, there have been substantial efforts to assess the possibility of electrification of the fleets through studies by GGGI and the Ministry of Environment (MoEnv). The need for further incentives was spelt out; suggestions to address

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this included sourcing climate finance such as the Green Climate Fund (GCF). It is notable that plans for the BRT have started since 2008, indicating the lengthy execution process for such a project even without the additional task of electrification. However, it is possible to leapfrog, not only among the 18m trunk route buses but also the 12m feeder buses, which would substantially exceed 100 buses. The Greater Amman Municipality (GAM) is in any case considering electrification in phase-2, while observing the outcomes of the demo project in operation in Amman, the Amman Bus.

- **Amman Bus 15 Electric Buses:** Amman Bus, a leading operator under an investment company owned by GAM (Amman Vision), is due to roll out 15 electric buses of 9-meter sizes, in addition to procurement of 100 Euro-V diesel fueled buses. It is through support by EBRD's €20-million loan. The 15 electric buses will be jointly financed by EBRD and GCF (€5.6 million). This activity is a result of Amman's participation in EBRD's *Green Cities Program* and the related Green City Action Plan (GCAP) that was recently launched by GAM. The tender for this phase has been released, and the experience is expected to provide learning for cities pursuing such scale of demonstrational projects, based on holistic planning involved in developing a GCAP. EBRD shall no longer fund diesel buses after this project. The case study confirms the growing market for buses in general, predominantly Euro-V. it also sheds light on the slow pace of EV penetration to date.

- **Aramex Electric Vans:** The Dubai-based courier company, Aramex, introduced 10 e-vans in Amman manufactured by Chinese company BYD, with plans to eventually have a global fleet of 2,000 EVs. They use dedicated Level-2 AC chargers and largely use solar energy.

  The experience shed light on common hurdles that may be faced by the private sector, but also demonstrated how a business case was made possible in the case of high-use vans. Electric vans were 20 percent more expensive than the ICE equivalent, but savings and corporate policy justified and motivated the project. It can be seen so far as a success story, but battery replacement timing and costs are yet to be evaluated. Several lessons learnt have been noted that are associated with uncertain tax regulations, uncertainties in insurance services for the novel technology, and the need to better plan infrastructure for scaling.

- **PDTRA Electric Buses (grant):** The Petra Development and Tourism Region Authority (PDTRA) rolled out two fully electric buses as a pilot project in 2019 in Petra. They expect they would need 10 buses in the future, considering inflows of visitors at times exceeding 1 million per year. The 11-meter buses and charging stations were provided as a *grant* from Hyundai, and are owned and operated by PDTRA. The experience proved technical viability, which may facilitate future expansion if/as costs decline or incentives are provided.

- Among common barriers such as limited planning for infrastructure requirements, several other impediments to expansion have been identified that range from fragmentation of roles and responsibilities, to specific irregularities in incentives. For example, there is a 30 percent custom duty on electric buses, but only 15 percent for diesel buses; e-vans also attract 16 percent sales taxes, and so on.

- There are, however, promising developments to address these challenges, including a recent positioning of the Ministry of Energy and Mineral Resources as the overarching authority leading the coordination of the e-mobility strategy at the national level, and the expected UNIDO project with complementary planning support. At the city level, most significant progress will likely be in Amman where the EBRD's Green City Action Plan (GCAP) development is in process. The associated move towards bus fleet electrification will likely be an informative experience once in operation.

Amman is also among the C40 Resilient Cities initiative, a network of world's megacities committed to addressing climate change. The city also has developed a climate plan with support from the World Bank (WB).

- Various project examples have been noted for indicative purposes, including the potential expansion of the Amman Bus pilot project and its possible replication in other large cities like Irbid. There is also the expansion of the charging infrastructure after necessary prerequisite studies, electrification of buses in the second phase of the BRT system of Amman and Zarqa, expansion/replication of electrification of bus fleets in touristic cities like Petra, or Aqaba, and Wadi Rum, in addition to developing capacity for managing batteries life cycles and building the relevant competences for maintenance, reuse, and recycling.

- This report has concluded recommendations for planners and development partners for the observed stage of early development of Jordan. These are in response to the key barriers to development of e-mobility.

Morocco Case Study

Limited information is available about Morocco's status with regards to on-road electric mobility, although substantial electrification is noted in the case of expansions of electric tramways in the wider scope. A substantial opportunity for improvement is noted, especially with the high rates of urbanization. An overview of the country's status has been reviewed through research and stakeholder consultations, with key highlights as follows:

- Morocco has a growing population of 36 million, and a large vehicle stock exceeding 4.3 million vehicles. With a growth of well over 5 percent a year, and more than a third of vehicles still more than 20 years old, meeting sustainability targets is a challenge, and the move toward collective transport is imperative.

- Several milestones and actions point to political will and commitment towards sustainability. These include Organization of the COP22 in Marrakech in 2016, the due submission of the Nationally Determined Contributions (NDCs) to the UNFCCC in the same year, and the adoption of 2030 Strategy for Sustainable Development in June 2017, along with several plans and strategies of similar nature, most notably the **2018 *Roadmap for Sustainable Mobility*** prepared by the Ministry of Transport with the support of GIZ and the Energy and Engineering Company, SIE.

- At the **city-level, ten-year *urban mobility plans* are mandated,** some of which have been upgraded to Sustainable Mobility Plans (SUMP) in alignment with global best practices through the project of *Mobilize Your City*. Implications are noted in the expanding use of electric tramways, and initiation of attempts for electrification of vehicles, although mostly being light duty vehicles, along with other improvements in the sector. However, none of the national-level or city-level plans or strategies in place are specifically dedicated to e-mobility, whether catering to EVs in general or e-buses in specific.

- However, Morocco's progressive development of legal and regulatory framework characterized by **decentralization and autonomy of municipalities** is a positive in this regard. They can create a Local Development Agency (Sociétés de développement local) to oversee economic activity of the municipality including public transport. The bus systems are commonly operated through **concession agreements with private operators.**

- Among the challenges faced by bus systems is the **need to optimize** the design of the bus routes and operational plan along with the other modes of transport to adequately match demand and optimize revenues. There is also the challenge of maintaining the low fare prices that are subsidized to date.

- There are only limited experiences with regards to electric buses, but generally successful as exemplary flagship projects: **15 electric trolley buses in Marrakesh, and 4 electric tourism Double Deckers.** Dedicated plans and strategies are not yet in place for electrifications of bus fleets or for promoting e-mobility in general.

- A notable policy in place is the mandate to ensure that **10 percent of all new procurement of public vehicles is electric; the state is leading by example in this regard** as per a recent directive in 2019. However, this also points towards the urgent need to correspondingly plan for the consequent ramp-up in demand of EVs as well as assess the adequacy of the current financing models for projects with high upfront costs.

- There are however **no dedicated incentives** for electric buses although tax exemptions may be provided on a case-by-case basis. Procurements therefore have to be made to meet mandates with whatever higher upfront costs this entails.

- Case studies of relevance include the following, with highlights of lessons learnt respectively:

    - **Marrakesh E-BRT:** In 2017, first E-buses (electric trolley buses) were put into operation in Marrakesh with partial integration with renewable energy. The model involved using battery-electric buses, that partly function as E-buses and partly as trolley buses, over 3km for in-motion overhead charging. Prospects for fleet expansion in Marrakesh and in other cities include expanding local manufacturing in cooperation with leading players, most prominently Chinese companies. There are also options worth considering for fleet renewal through projects implemented as public-private partnerships. The flagship project is successfully in operation, while some concerns remain with regards to optimizing the route design and operational plan in the design phase of such projects to ensure optimal ridership.

    - **Electric Tramways and potential electrification of feeder buses:** Despite the lack of examples of bus fleet electrification, the expansion of electric tramways provides way forward for successful PPP projects implementation as well. The case of Rabat shows how the electrification of the stock of feeder buses in the city can be used as an example of potential expansion in electrification of the transport sector in the city. This can also be a model for other cities operating tramways, such as Casa Blanca. ALSA Morocco alone operates 350 buses in Rabat.

- Despite the improving vehicle standards and the gradual introduction of EVs in public transport, an overall e-mobility strategy or city-level bus fleets electrification strategies are yet to be developed. These would include planning for ramp-up in demand, exploring vehicle-to-grid applications, grid impact assessment and RE integration, planning for battery collection and recycling, setting tariff schemes and planning billing systems, promotion of local production, enhancing after-sales services, and so on. This report provides several recommendations to guide planners and development partners for the road ahead.

- With adequate technical assistance for city-level planning for developing and scaling up electric bus systems and bus systems in general in the context of existing SUMPs, the cities of Morocco are at an adequate level of readiness for such expansions and operation through PPP set-ups.

- In comparison with other countries in the MENA region, including Egypt and Jordan, the diesel prices in Morocco are substantially high (0.83-1.09 USD/l). For example, it is more than double the price in Egypt, where it is subsidized, while the electricity price is similar in both countries. The difference in operational cost in Morocco is therefore significantly larger than in other comparable countries with low diesel fuel prices. This, along with the fact that the diesel buses in Morocco are required to be of high Euro standards implying high upfront costs compared to diesel buses procured at lower standards elsewhere in some MENA countries, favors the relative competitiveness of electric buses in Morocco. This should be highlighted in detailed TCO analysis in future studies.

- In Morocco, a substantial advantage in planning is the requirement to develop urban mobility plans – at times upgraded to *Sustainable Urban Mobility Plans*. This is further aided by the relative decentralization and autonomy enabled in transport planning. Such city-level planning can be a key area of experience-exchange in future cooperation initiatives among the three countries.

- Experience-exchange and locally-tailored capacity-building is noted as a common need across all three countries reviewed herein. There is a substantial opportunity for development, specifically in Egypt and Jordan, in further boosting e-mobility with valuable experiences from Morocco – by way of gradual improvement in the definition and understanding of roles and responsibilities, and improved decentralization and city-level planning.

- A summary table to capture the highlights of each country is included in the following page to give a perspective. Among the key highlights is the prevalence of substandard diesel buses in Egypt. The second highlight is the significant price difference between diesel fuel and electricity in Morocco in the favor of EVs as compared to that in Egypt and Jordan.

Table-1: An overview of case-study countries discussed; Egypt, Jordan, Morocco.

	Egypt	Jordan	Morocco
Population (millions)	102	10.2	36.9
GDP/capita (USD)	3,548	4,283	3,058
GDP Growth rate (10yr average, 2020)	3.6%	2.4%	2.0%
Stock of Public Transport Buses	16,000	5,169	2,783
Electricity (USD/kWh)	0.11	0.21	0.11
Diesel (USD/liter)*	0.43	0.74	0.97
CNG (if used) (USD/m3)	0.22	-	-
Standards for ICE Buses in new procurements	Euro-III for new buses procured, but compatible fuel not available (i.e. no emission control devices are possible in the operating buses). Accordingly, although Euro-III vehicles in operation, there is no possible compliance with Euro-III emission standards (or any preceding Euro standards), warranting urgency in action.	Euro-V due to availability of compatible low-sulfur diesel fuel.	Euro-V due to availability of compatible low-sulfur diesel fuel.
E-Bus Incentives/ mandates	▪ No announced incentives or mandates. ▪ Plans for partial local production in partnership with Chinese OEM's (2000 e-buses over 4 years), yet no accompanying roll-out plan or incentive schemes yet. ▪ Case-by-case custom duty exemption could be sought in the past, but priority is in enabling the prospective local production.	▪ None (history of fluctuating incentive policies for electric cars, but none for buses yet). ▪ Case-by-case custom duty exemption can be sought.	▪ Implementing National Strategy for Sustainable Development (NSSD, 2017) mandating 10% of new state-owned vehicle procurements (all types) to be electric. ▪ Case-by-case custom duty exemption can be sought.

	Egypt	Jordan	Morocco
Electrification Status & Prospects	▪ 15 Electric 12m K9 BYD buses in operation in Alexandria since 2020, owned and operated by Alexandria Passenger Transport Authority (APTA), using overnight charging primarily, along with opportunity charging. ▪ Other 6-month trial implemented in Cairo ▪ Electric bus used in Giza Pyramids Plateau ▪ Electric bus(es) planned for a short route (labeled "BRT") between Cairo Airport and the "Adly Mansour" flagship transport hub. ▪ Demo project of 100 electric buses along with required prerequisites currently in preparation through the support of the World Bank spanning until 2016. ▪ Support to leverage current local production plans/pipeline is a government priority.	▪ 15 e-buses within Amman Bus fleet due to be introduced in Greater Amman Municipality (GAM) in cooperation with EBRD (along with a large fleet of 136 Euro-V diesel buses) as part of the EBRD Green Cities Initiative. ▪ Aramex: 10 pilot electric vans ▪ 2 pilot e-buses in Petra, owned and operated by Petra Development and Tourism Region Authority (PDTRA), granted by Japanese OEM for piloting and promotion, along with DC charging equipment. ▪ Most EVs promoted are still light-duty vehicles/ cars (e.g. e-taxis program, state-owned electric cars, etc)	▪ 15 electric trolley buses in operation since 2017 (partial in-motion charging through 3km overhead charging). Solar PV energy source is integrated for partial displacement of carbon-intensive grid electricity. In-motion charging reducing battery size requirement but restricts route-flexibility and increases infrastructure cost. ▪ 4 touristic double-decker buses in operation

**Here energy prices are indicated only to note differences between countries. To estimate the cost-per-kilometer, energy consumption data is necessary. However, an approximate estimate can consider that for large buses, the figure of kWh consumed can be approximately double the figure of liters consumed, although warranting substantial necessary on-road testing data due to expected wide variation in technologies as well as differences between driving cycles and differences between manufacturer's data and actual performance. Accordingly, the following is noted for indicative purposes only: (a) In Egypt, OPEX costs of diesel are more than double electricity per km, but CNG is similar, (b) In Jordan, OPEX costs of diesel is also higher per km, being 60-80% more, (c) In Morocco, the highest difference is noted, where diesel is approx. four times the cost of electricity per km. Relative savings are therefore highest in Morocco. But foreseeable pricing interventions can largely influence the scenarios (e.g. electricity is subsidized specifically for the Metro line in Egypt).*

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01

INTRODUCTION

The Center for Environment and Development for the Arab Region and Europe (CEDARE) and the Islamic Bank for Development (IsDB) signed a Memorandum of Understanding (MoU) in November 2019 to provide a general framework for facilitating collaboration and cooperation among stakeholders in areas of common interest. 'Sustainable mobility' was identified as one such area, as part of which this report has been prepared. This exploratory study focuses on electric mobility with focus on electric buses in specifically three countries of interest, Egypt, Jordan, and Morocco. The objective is to assess potential project development opportunities in the field.


ELECTRIC
Centrum
Jörntorget
Klippan

1.1 Objectives

This study is exploratory in nature and focuses on assessment of Electric Bus systems, in addition to the general status of e-mobility in Egypt, Jordan, and Morocco. The aim is to provide recommendations to Multilateral Development Banks (MDBs) for areas of interest for further future investigation and identifying possible synergies with other activities/ initiatives elsewhere. The objectives are accordingly as follows:

- Develop a Situation Analysis and preliminary market study for Egypt, Jordan, and Morocco, for the advancement of electric bus systems within the larger context of e-mobility development.

- Identify barriers to entry and opportunities for investments and recommendations to MDBs and key stakeholders.

1.2 Approach

This report is based on both extensive desk research and stakeholder interviews and through meetings with key players in each of the markets – Egypt, Jordan, and Morocco. These were conducted by a team of national experts in the three countries with expert input and analysis.

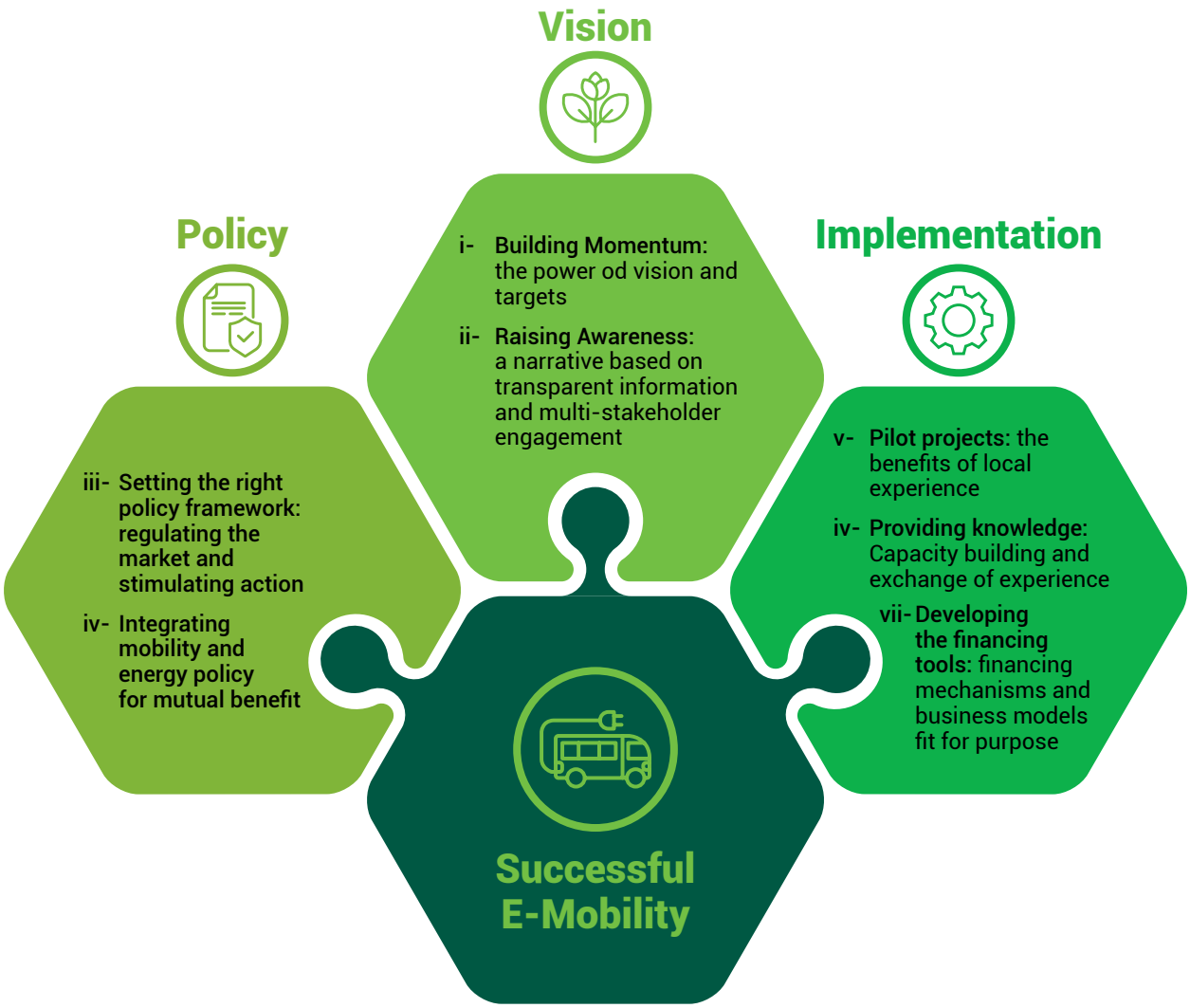
Firstly, global knowledge was reviewed with the aim of identifying relevance to the local context, followed by situation analysis and stakeholder assessment and interviewing, leading to identification of barriers and opportunities for investment. Finally, recommendations are provided targeting the major stakeholder groups – international development community including multilateral development banks, the national public policy community, and local public policy community. The report also provides a discussion of common elements at a regional level that may benefit from south-to-south experience exchange and joint activity.

The study has been conducted in close coordination and communication with the IsDB and the Transforming Urban Mobility Initiative (TUMI) of the GIZ. It accordingly builds on, and aligns with, the guidance publication produced by the Sustainable Mobility for All (SuM4All) Working Group on Electric mobility in 2020 under the leadership of the group co-chairs, TUMI and UITP.

1.3 Sustainable Urban Mobility for All (SuM4All)

The framework of analysis used in the report builds on the conceptualization developed by the Sustainable Urban Mobility for All (SuM4ALL) working group with which this study is aligned. It identifies various mutually reinforcing building blocks necessary to create the necessary policy environment, grouped into three key action fields; Vision, Policy and Implementation[1].

Figure 1: Conceptualization of the building blocks necessary for the development of enabling environment for e-mobility developed by SuM4All Working Group[2]



The framework indicated in Figure 1 represents the convergence of much of the international experience towards a common understanding of the way forward for successful e-mobility. it has accordingly been used as the framework for analysis and a basis for discussing the gaps in each country targeted in this study. However, the specific scope is that of on-road e-mobility with focus on bus systems.

SECTION

02

GLOBAL OVERVIEW

The Paris agreement, enforced in 2016, set the global commitment to limit the increase of global temperature to °2C above pre-industrial levels. According to the International Energy Agency, this demands substantial electrification of global rail transport and that at least 20 percent of global road vehicles to be electrically driven by 2030 . In order to discuss the status in developing countries of interest, likely to be 'late-adopters', the global context must first be understood through the lens of middle- and lower-income countries, which often places more emphasis on opportunities for near-term economic development and job creation. The opportunity to tap into global development assistance is another driver for these countries.

2.1 Highlights of global developments and context

The following highlights indicate substantial progress to date, in both developed and developing countries as assessed in key references, including the 2020 Global EV Outlook of the International Energy Agency (IEA)[3,4,5,6,7]:

- Electric vehicles increasing in stocks, and battery prices declining:
    - **Electric Cars:** In 2019, electric car sales touched 2.1 million, or 2.6 percent of global car sales, indicating continued but slower growth than previous years. Overall, the stock reached 7.2 million, about half of which are in China.
    - **Electric Buses**: Global stocks are estimated to exceed 500,000 electric buses, with about 98 percent in China. But they are growing rapidly in other countries as well, most prominently in Chile. COVID-19 had a negative impact on collective transport in general due to reduced demand as well as lower oil costs, but the nature and duration of impact is yet uncertain.
    - **Micro mobility**: About 350 million electric two/three wheelers, constituting 25 percent of all such vehicles worldwide, are once again mostly in China. Shared electric scooters (e-scooters, or e-kick-scooters), electric-assist bicycles (e-bikes), and electric mopeds, are now available in over 600 cities in 50 countries.
    - **Electric Trucks**: Over 6,000 units sold in 2019.
    - **Battery**: In broad terms, battery costs have decreased by 85 percent since 2010.
- **Governments are still subsidizing, but shifting towards policy approaches such as emission mandates and LEZ regulations**. On the back of support to costly deployment of charging infrastructure, e-mobility is forging ahead in leading countries, largely supported by strategic policy thrust in the form of fuel economy standards, associated incentives and economic instruments, including various tax exemptions and subsidy schemes to bridge the cost gap between electric and conventional vehicles. Partial or full *incremental cost* coverage, and infrastructure investment are some examples of how this is being done. However, in 2020, the phase-out of incentives has been softened in response to COVID-19 to reduce impact on the consumer and the industry. Examples include China, Italy, and France. There is also the cost factor. Although incremental costs can be prohibitive, exceeding 150,000 USD per bus for example, the subsidies can be regarded as an *investment* in stimulating local innovation and industrial development. The future gains of an emerging industry together with expected decline in incremental costs must be seen as a trade-off against the high upfront cost.
- **Countries have started to phase out ICE(Internal combustion engines) vehicles.** As many as 17 countries have announced 100 percent zero-emission vehicle targets or the phase-out of internal combustion engine vehicles through 2050. France was the first country to put this into law in December, 2019, with a 2040 timeframe.
- **Fuel tax revenues are in decline, and governments need alternative revenue sources.** In many countries, an emerging challenge is that transport-related tax revenue is falling due to the successes in reducing consumption with more efficient ICE vehicles, better urban planning, new technology, improved

On the back of support to costly deployment of charging infrastructure, e-mobility is forging ahead in leading countries, largely supported by strategic policy thrust in the form of fuel economy standards, associated incentives and economic instruments, including various tax exemptions and subsidy schemes to bridge the cost gap between electric and conventional vehicles

> Power grid operators are preparing to accommodate increased future power demands and integration with renewable energy

environmental awareness, and shift to public transport and cycling, among others. To offset this, alternative tax revenue can be generated through increases in taxes on conventional fuels, as well as a shift toward distance-based or per-use charges.

- **Battery lifecycles and supply chains are under the spotlight, greatest future demand will be cars in specific.** With increased EV uptake, more attention is being directed toward the *cradle-to-grave* or cradle-to-cradle life cycle of batteries at global and national levels. Regulation is being strengthened to ensure sustainable sourcing of raw material for batteries, and promote re-use options. Battery end-of-life management is underway, whether by advancing second-life applications or promoting recycling and disposal, or battery design. All objectives are being pursued through a combination of regulation, practices and technology.

- **Power grid operators are preparing to accommodate increased future power demands and integration with renewable energy.** According to announced policy ambitions and targets, the global EV stock by 2030 is expected to exceed 130 million vehicles, excluding two/three wheelers, with global EV sales of 23 million. Improved power system management is needed to accommodate the foreseen increase in electricity demand implied – 640 TWh in 2030 – and use grid balancing to conform to loads and synergize with renewable energy sources.

- ***Hybrid* vehicles are favored over full-electric ones in countries with most carbon-intensive power grids.** Carbon savings of full-electric vehicles are substantial since EVs continue to have lower emission rates than conventional vehicles, **even on a Well-to-Wheel (WTW) basis**. However, in countries where power generation has high carbon emission values, for example those dominated by coal with little renewable energy sources, then *hybrid* electric vehicles may be found to emit less WTW carbon emissions than fully electric vehicles. However local emissions will be of concern.

- **Original Equipment Manufacturers are announcing ambitious targets.** Numerous OEMs are increasingly shifting toward electrification of their offered models, whether cars or other vehicles. Additionally, investments in battery technology is substantially growing, most notably in Europe and China.

- **Costs are declining.** Costs of production continues to decline gradually, mainly thanks to advancements in battery chemistry and economies of scale, but also through cuts attained through improved vehicle manufacturing platform designs, and application of big data to improve battery sizing. Whether in commercial fleet vehicles, private cars, or otherwise, *rightsizing* is emerging as a big contributor to cost-reduction.

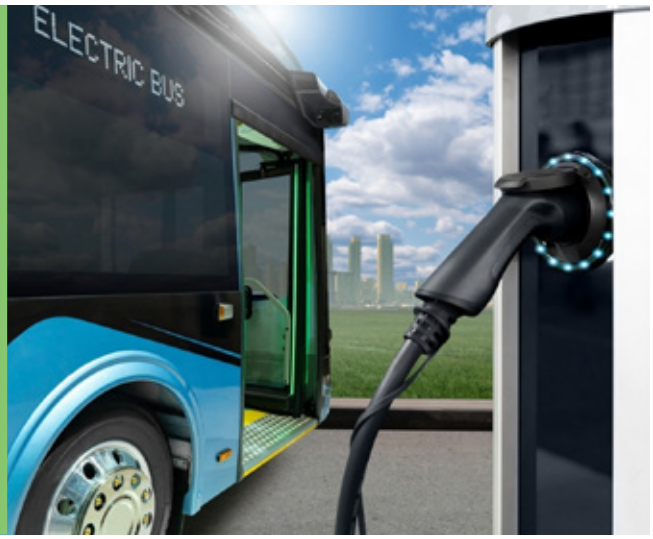
Globally, advancements in urban mobility are shaping into **three clear transformational trends: Sharing, Electrification, and Automation**. These are major enough to have been labeled by some as the "three revolutions" in the transportation sector[8].

Automation mainly refers driverless vehicles, or vehicles with various levels of autonomy. Shared mobility refers to purchasing the *ride* and not the vehicle. It involves a cultural shift towards the shared economy and generally refers to two common types of services: (a) *Ride-sharing* or ride-hailing, of which Careem, Uber, Lyft, are examples; and (b) *Car-sharing or other vehicle sharing*, where publicly available vehicles are available for public use, Car2Go, Zipcar, being examples of the category. The terminology, definitions, and models are in continual development and vary among countries.

Although 'electrification' and 'sharing' are not mutually dependent, they are rapidly developing *in tandem*, often involving elements of autonomy. Shared electric microcars is a clear example. The density of cities, scarcity of public space, and increasing air pollution, are all driving innovation in mobility solutions towards lower emission and lower vehicle ownership for more livable cities.

Shared mobility stakeholders are therefore significant actors in the advent of EVs. In one prominent example, Uber is phasing in EVs in London until all its fleet in the city become hybrid or fully electric vehicles[9,10]. Elsewhere, electrified micro mobility services, such as shared electric kick-scooters are rapidly expanding in many cities around

The case for electric vehicles is also strengthened by cost cutting achieved by second-life applications for batteries by way of refurbishment or stationary storage applications. This can even double battery life, depending on battery degradation, temperature exposure during operation, charging/discharging patterns, and time



the world and promise to also provide last-mile solutions as they are integrated with public transport, including bus systems.

2.2 Electric Buses and "rightsizing"

Electric buses have mostly been deployed in the realm of public transport, thus benefiting from the advantages of possible systemic solutions in cost reduction. Due to the high costs of batteries, this area of cost savings is of great interest. Through "rightsizing", systems can be designed to reduce the battery capacity needed in the fleet vehicles. Accordingly, with adequate understanding of operational needs, the charging infrastructure can be designed optimally, and the battery capacity requirements, among other specifications, optimized to reduce costs. This is further greatly enabled through improved data analytics to support system optimization planning.

2.3 Considerations for Total Cost of Ownership for buses

Comparison of diesel buses with Electric buses should not be confined to initial cost comparisons, nor should it be on the basis of Total Cost of Ownership (TCO) as a stand-alone vehicle. Rather, the two are best compared in terms of TCO *within* available system-level solutions – systems that optimize battery size and infrastructure requirements.

A good example of this can be seen in many Indian cities where TCO of a common 12-meter e-bus can be 50-100 percent higher than a conventional diesel and CNG bus, even with the support schemes[11]. Incentives include a capped 40 percent demand incentive of estimated bus procurement costs. Higher bus use cases therefore are ideal options for e-bus adoption. The incentive scheme, *Faster Adoption and Manufacturing of (Hybrid and) Electric Vehicles (FAME,)* is presently under way in its second phase. Administered by the Department of Heavy Industries (DHI), it aims to generate demand by supporting several types of electric vehicle with the approximate targets given below, indicating a powerful example of a developing country proactively investing in the transition[12]:

- **7000 electric buses**
- **500,000 electric 3-wheelers**
- **55,000 electric cars**
- **1,000,000 electric two-wheelers**

Many of the consortia in Phase-I of FAME scheme were OEMs such as PMI Electro Mobility Solutions (Foton-PMI) and Olectra-BYD, among others. Most of the the e-buses that were deployed are 9-m in size, in addition to12m buses in smaller number. Tenders vary between 25 buses per tender to more than 300, and payments to service providers are distance-based[13].

The case for electric vehicles is also strengthened by cost cutting achieved by second-life applications for batteries by way of refurbishment or stationary storage applications. This can even double battery life, depending on battery degradation, temperature exposure during operation, charging/discharging patterns, and time. Second-life applications include peak-shaving, storage for renewable energy systems, backup power, among others.

If the costs accruing from health and environmental damage are factored in, the comparative advantage of e-mobility is further strengthened.

2.4 Charging infrastructure for buses and grid impact

Charging infrastructure needs depend on service frequency, distances, and dwelling (waiting) times. The common charging strategies are *overnight depot charging* and *opportunity charging*. The advantage of opportunity charging is that due to the possibility of frequent charging,

the batter size can be smaller, which translates into cost saving. Still, infrastructure requirements must then be taken into account among other trade-offs.

The technology options for charging are mainly as follows, including combinations thereof:

- Plug-in charging (slow charging, fast/opportunity charging, and combinations thereof),
- Pantograph (overhead lines, adequate for on-route opportunity-charging in the case of hybrid trolley buses),
- Inductive/wireless charging.
- Battery-swapping.

Although less-used strategies such as battery-swapping and inductive charging are available, the main approaches found practical throughout most global experiences has been various forms of plug-in charging, followed by pantograph charging.

Battery-swapping is likely to imply substantial cost increase among other challenges associated with operationalization. It is however a valid option to explore in specific context where certain benefits are worth the trade-off. e.g. reduced needs for grid reinforcement, reduced need for high-capacity batteries, among others).

Overnight depot charging can fall within a common range of 50-250 KW, adequate for buses with low daily mileage or large batteries.

Electrification of bus fleets is most viable among urban buses due to shorter distances, and higher relative savings in the driving cycle.

Grid reinforcement needs and system-level solutions

Depot charging with large fleets requires adequate planning for charging infrastructure and grid-reinforcement.

As an example, 1,000 E Buses charging with 50 KW power each,a conservative assumption, would imply 50 MW of power requirement or more in the same charging period. This is a substantial capacity need. Although excess power production capacity is available in Egypt, the existing infrastructure in the dense and old cities where electrification is needed most, is a challenge, along with the further challenge of limited public space. This may be addressed through in-depth studies to develop tailored system-level solutions. Furthermore, future prospects of replacing fast chargers with ultra-fast chargers imply greater grid impact. However, several solutions are in place to either mitigate such impact, or upgrade the power grid as required.

Accordingly, *system-level* charging strategies need to be developed before deployment of electric buses. For this, trade-offs need to be assessed between requirements of different charging strategies for fleets, including different configurations that can combine different charging strategies, energy storage options, and corresponding fleet specifications requirements.

> Although excess power production capacity is available in Egypt, the existing infrastructure in the dense and old cities where electrification is needed most, is a challenge, along with the further challenge of limited public space. This may be addressed through in-depth studies to develop tailored system-level solutions.

Each city must therefore answer the following questions for bus systems when contemplating electrification:

- **Needs:** What targets and service requirements for public buses are needed now and in the future? What likely power needs are implied?
- **Status:** What is the status of the power grid to accommodate foreseeable scenarios of electric power demand in terms of quality, quantity, and time)?
- **Scenarios:** What combination of depot (overnight) charging and opportunity (on-route) charging is most feasible with consideration of implications for needed battery capacities and costs and on the current power grid status? What other cost-saving solutions are viable in a specific context at a system-level?
- **Practicality:** How sophisticated can a practical solution be in the local context? Cases in point include competencies available for management of certain approaches such as staggered charging, or use of distributed energy storage, or other flexibility solutions.

The issue of practicality involves the assessment of capacity of the current public authorities and relevant stakeholders, in addition to systems in place for operationalization of the electric bus systems.

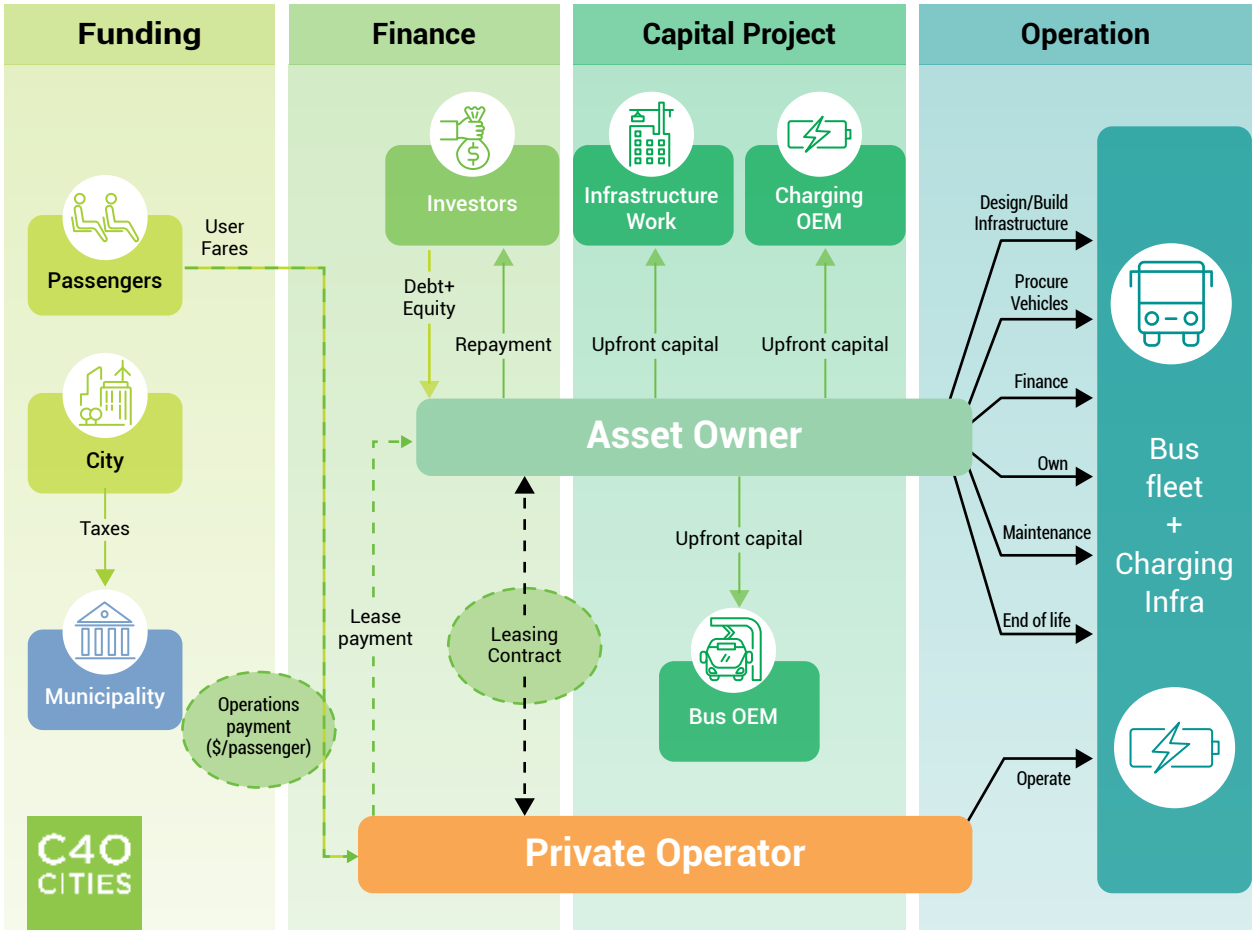
2.5 Institutional set-ups and financing models

Even as cost decline and many technical and operational challenges get resolved with time, the challenge with regard to optimal financing models appropriate for deployment of electric bus systems remains significant. E Bus deployments are characterized by technology risks and high upfront costs despite competitive total cost of ownership, among other characteristics that may require alternative financing models.

The primary approach to such challenges, as advocated by the leading players and alliances in the field – C40's Zero Emission Bus Rapid-deployment Accelerator [ZEBRA], ICCT, UITP, among others – revolve around leasing solutions, and associated 'unbundling' of asset ownership and operation. This has been found to be suitable for distributing risks and eliminating the barrier of high upfront costs faced by municipalities and operators[14].

Santiago de Chile, among the earliest players in Latin America in deploying substantial number of electric buses since 2018, is a prominent example of a city making use of leasing arrangement in introducing e-buses. Under this model, operators lease chargers and electric buses from their partnering energy companies, such as ENEL X and

Figure 2: An example of an 'unbundled model' separating ownership from operation and facilitating bankability (courtesy of Anthony Courreges, C40[15])



ENGIE, which own the assets[6]. Other variants of such schemes are being explored in more cities in recent years for adaptation to local contexts[16].

Countries or specific cities exploring the potential for large-scale roll-out of electric bus systems are therefore advised to assess the different financing models and institutional set-ups of public transport, in addition to the existing and required legal and regulatory framework, to develop unbundled models as necessary.

2.6 Electric Buses in the MENA region

In a recent mapping of the pilot projects of electric buses in the Middle East and North Africa (MENA) region, the International Union for Public Transport (UITP) shed light on the status of demonstrational projects in recent years up to 2020. This is summarized in the table below. It indicated the relatively early stage of development in the region, and also highlights the prevalence of Chinese OEMs dominating this phase.

Table 1: A summary of the status of electric buses in public transport in the MENA region (UITP 2020, edited[17])

Country/city	Description
Egypt Alexandria	15 Fully-electric *BYD* K9 buses, owned and operated by the Alexandria Public Transport Authority (APTA), rolled out in 2020, and continued operation.
Cairo	Pilot projects and trials: (a)1 *Shanghai Wanxiang* Fully-electric bus tested for 6 months on the road in 2020 by private operator Mwasalat Misr, (b) Cairo Transit Authority (CTA) piloting two fully-electric *Foton* Buses in 2020 with prospects for future local production possibilities, leveraging available facilities of the Ministry of Military Production.
Morocco Marrakech	15 fully-electric *Yangtse* electric trolley buses (in-motion overhead charging) rolled out after hosting the COP22 in 2016. Buses are owned by Société de Développement Local (SDL; local development company executing the municipal project) and operated by ALSA Marakech.
Qatar Doha	Piloting fully-electric buses in September 2018 (Chinese OEM) with plans to have 25% of the public bus transport fleet being electric by 2022; associated with plans for preparations to host the FIFA World Cup.
Tunisia Tunis	Piloting a *BYD* K9 fully-electric bus over 6 months in 2018, with prospects to explore local production potential.
UAE Dubai	Dubai Road and Transport Authority (RTA) testing novel technologies such as wireless dynamic charging (inductive charging, specifically *Shaped Magnetic Field In Resonance (SMFIR) technology*) ongoing since 2015 in Dubai Silicon Oasis, and conducting trials for fully electric buses of Yutong in 2019 and Volvo in later plans using opportunity charging.
Sharja	Sharjah Road & Transport Authority (SRTA) piloting fully-electric Changhan buses in 2019.

Other than for the purpose of regular public transport, applications in tourism are also notable. This includes the deployment of two electric buses in Petra, Jordan, and three in in Marrakesh, contributing to branding of tourism sites.

The common observation noted in the overview of electric buses in the MENA region was the lack of prerequisite strategic planning for fleets and infrastructure in most cases, and means to enable scalability in the form of financing models, incentives needed, among others. A more in-depth overview of each country is necessary to better identify such gaps.

The section below makes an attempt to refine the understanding of three countries in the MENA region in the deployment of E buses. The cases of Egypt and Morocco are discussed as examples of countries that may offer high impact by virtue of their large population, and that of Jordan as one that has not yet rolled out electric buses in public transport services despite significant advancement in electric cars and two-wheelers.

2.7 Public participation

Procedures for public participation are gradually becoming mainstream in the MENA region. Much of the progress here is partly encouraged through the financing prerequisite requirements of the development community or the multilateral development banks).

Furthermore, local requirements for environmental and social impact assessment (EIAs or ESIAs) for transportation projects established in the three countries of study are the main framework available to ensure public participation, at varying degrees, in all infrastructure projects. This also involves post-project monitoring and evaluation, and availability of channels for grievance and complaints as part of the plans for monitoring, evaluation, and risk mitigation included in EIAs.

SECTION

03

EGYPT

Egypt is among the earliest countries worldwide to adopt electric rail transport or tramlines since the late 19th century, and later constructing Metro lines since the 1980s. Yet with regards to on-road electric vehicles however, it is in the early stages of adoption of e-mobility as discussed herein.

3.1 Overview of transportation sector and general directions

The current strategy for the transport sector in Egypt is guided by the plan of the Ministry of Transport for the years 2020-2024 with an announced budget of EGP 1.1 Trillion. It is being implemented at an unprecedented pace after decades of limited progress. The plans are inspired by the preceding masterplans and studies for transportation and logistics developed both for Egypt at large and for Greater Cairo in specific.

The discourse is mainly focused on catering to the following priorities:

- Catering to industrial development – dry docks, harbors, roadway upgrades catering to economic zones, among others.
- Catering to new desert cities to accelerate their development, and boost their value,
- Reducing vehicle traffic congestion in major cities through roadway upgrades and expansions,
- Accelerating the use of new technologies and novel solutions in the form of digitization, automation, intelligent transport systems development, and so on.
- Developing local capacities and localizing know-how and capabilities in all relevant fields.

While working on developing the transport sector, the Ministry of Environment is mindful of the need to integrate sustainability. This is in recognition of the necessary shift away from car-dependence towards various alternatives so as to also align with climate commitments. These include the United Nations Sustainable Development Goals (SDGs)[18], Egypt's Vision 2030[19] and the Egyptian Intended Nationally Determined Contributions (INDCs)[20] among others, whereby Egypt commits to both reducing emissions of Green House Gases (GHG) to curb climate change and also reducing local air pollution emissions for the sake of public health.

Policy context and direction

The transport sector in Egypt is currently being steered straight from the office of the President of Egypt as a development priority. The prime concern in the process is localizing know-how, reducing import dependance, and generating job opportunities.

In terms of the general direction of policies, laws and regulations, the focus is on the government's general move towards structural and administrative reform, gradually phase-out of fuel subsidies, shift towards more public-private partnership (PPP) models in implementing major projects where possible, and gradually shifting the government's role toward focus on regulation.

The focus in infrastructure projects is currently on mega-projects – road network upgrades and expansion, and diverse passenger transport and logistics infrastructure projects – with sustainable urban mobility within cities as the driver. A distinct characteristic of the ongoing developments is that the substantial capacities and resources of the Ministry of Military Production and its affiliated entities are being mobilized to meet the development targets.

It must be noted that policy development and planning

in the transport sector has for long been challenged by fragmentation of roles and responsibilities. However, in an effort to consolidate planning mandates, the Ministry of Transport recently developed an overarching organization for transport planning in Egypt. Established in 2019, a review of the *Land Transport Regulatory Authority (LTRA)* stakeholders is summarized in the Section1.5.

3.2 Transportation Infrastructure and Megaprojects in Egypt

This section presents a summary of the *2014-2024 Egyptian National Strategy for Transportation development* based on the strategy announced by the *Minister of Transport* as presented to the president of Egypt in August 2020. The review of the components associated with passenger transport specifically are reviewed herein.

The presentation reviews the most important pillars of the development strategy for the Egyptian transportation sector with its different sub-sectors -- *Tunneling and electrical traction projects, roads and bridges, railways projects, sea transport, onshore and dry ports, and finally river transport.* The strategy builds on preceding projects that were in the pipeline before 2014 but for long delayed for various reasons that are now being resolved rapidly to accelerate development.

Total investments per subsector

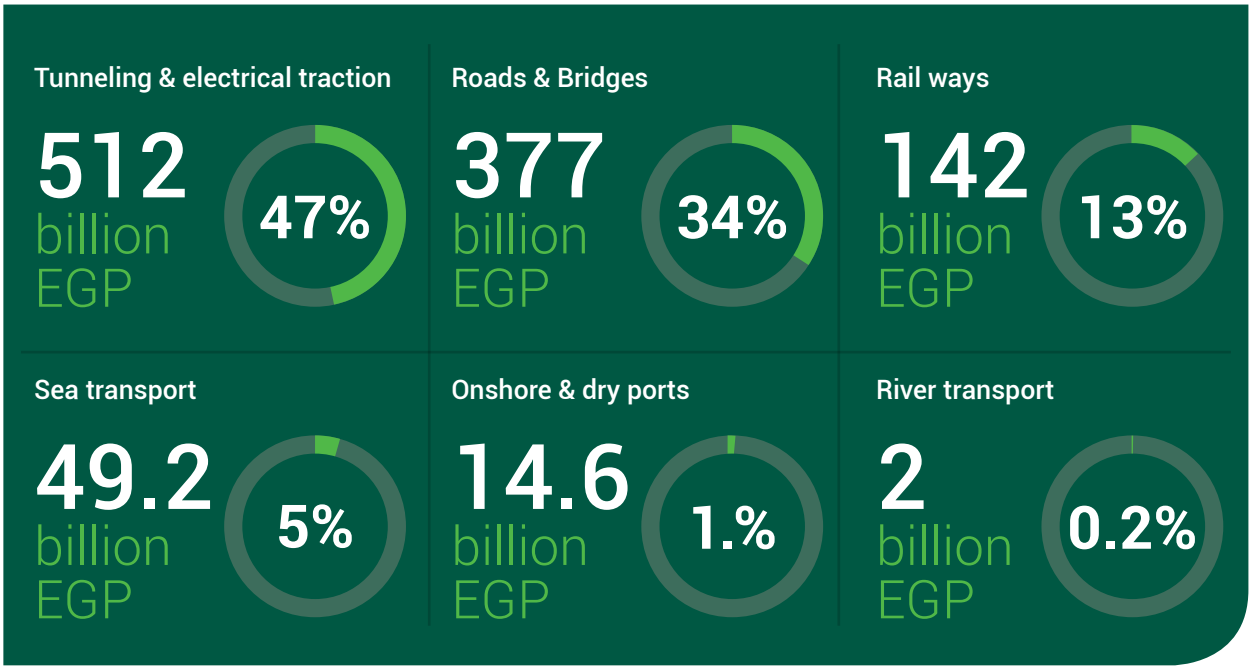
The total dedicated budget for the 2014-2024 transport strategy is **1.1 Trillion Egyptian Pounds** (EGP). The budget is divided on the basis of prioritizing the necessary development per sub-sector and by translating these developments into projects.

Figure 3 illustrates this division according to the MoT classification.

Projects in the country are largely implemented by local Egyptian companies, while under the technical supervision of international consulting companies. This kind of development is notable for generating substantial job opportunities, stimulating the local economy, and greatly aiding the capacity building of local skills and competence. A summary of projects associated with passenger transport are as follows:

- **Subsector-1, Tunneling and Electrical Traction Projects:** This subsector holds the largest part of the transport sector investment. It has different major connected projects, three of them are regional or inter-city, while the rest are focused on Greater Cairo Metropolitan Area (GCMA). The overall target is to add 862.4 km of electrical traction projects, 89 km of which are completed, 236.4 km are currently in progress, and 537 km are planned in the long term. This includes the following projects, falling within the larger scope of 'electric transport' projects. Though mainly still rail-based, minor consideration of electric vehicles is however noted:
  - **Cairo Metro Lines:** 3rd and 4th phase of Line-3, while further plans for Line-4 and Line-5 are in place.
  - **Light Rail Transit:** Mainly connecting the east fringe of Cairo to the new administrative capital, including a major interchange hub for the Metro, LRT, Monorail, Buses, Airport electric bus, regional buses, and trains as well as park-and-ride facilities.
  - **Monorail Lines**: 2 lines on the east and west sides of Greater Cairo, connecting to new settlements on either side.
  - **High-Speed Railway:** Connecting the Red Sea city of Ain El-Sokhna with the Mediterranean city of Al-Alamein passing through the new administrative capital.

Figure 3: Investments per sub-sector in Billion EGP



> The focus in infrastructure projects is currently on mega-projects – road network upgrades and expansion, and diverse passenger transport and logistics infrastructure projects – with sustainable urban mobility within cities as the driver.

- **Ring Road BRT:** Superimposed on the existing alignment meant for CNG-powered buses and prospectively *electric* buses, and including plans to develop feeder-bus systems and regulating microbus access.

- **Bus fleet enhancement with CNG and Electric Buses fleet** : A route of two demo electric buses to the airport, and a fleet of CNG buses at the flagship interchange hub of Adly Mansour station.

- **Other projects outside GCMA:**

  - **Delta Cities:** Intercity LRT between the Delta cities of Damietta and Mansoura.
  - **Alexandria:**

    - Abu-Quir railway transformation to a Metro line
    - Rehabilitation of El-Raml Tramway.

- **Subsector-2, Roads and Bridges:** The strategy includes a comprehensive plan for upgrading, developing, and increasing the efficiency of the Egyptian roads network. The following projects describe the highlights of the strategy. It is being executed over different layers ranging from the construction of additional inter-city highways, construction of 'axes' and bridges, to upgrading local internal roads which is already underway:

  - **National road project:** Constructing 7,000 km of the regional ring road, including Nile-crossing 'axes' and bridges every 25-km along the river.

  - **Major Highways upgrade:** 9,600km in the Delta of the existing 30,500km**.**

  - **Bridges and Tunnels/underpasses:** 1,000 bridges and tunnels of diverse types and functions dedicated to vehicular traffic flow improvement.

  - **Local internal roads in 12 governorates :**197 projects across 12 governorates covering 838 km of upgrades, and introducing green construction techniques for material recycling.

  - **GCMA road network upgrade :**18 connecting roads and 3 ring roads proceeding at different levels of upgrades/expansion/construction, and 27 internal roads completed with necessary bridges within the city.

- **Subsector-3, Diesel-powered Railway:** The railway service quality has been in decline since 2011due to limited maintenance and upgrading. This led to a decrease in ridership from 1 million passenger/day in 2009 to about **700,000 passenger/day in 2013 despite increased demand**. Through upgrading and developing of the current railway network, the new plan targets **reaching 2 million passenger/day in 2030**. The work is divided over three main phases – is 2020, 2024, and 2030 – to gradually keep in pace with the expected increase in population where the following major projects are being executed:

  - Expanding Network
  - Modernizing the signaling and control systems (automation)
  - Ensuring all crossings are safe
  - Upgrading 181 trains stations
  - Increasing rolling stock capacity and function and increasing the freight transport capacity

- **Other subsectors:** Marine Transport, Dry Ports, and River Transport which including substantial dredging activity to accommodate tourism and cargo ships, and developing River Information System.

Prospective Airport Shuttle Electric Bus

Notably, the only explicit mention of electric buses among the MoT plans has been in the prospective roll-out of the

Airport Shuttle buses. There are no shuttle buses of the kind, or any technology available at the moment.

In the current and planned public transport network, the provision of such a shuttle bus would connect the airport to Cairo's Metro Line No.3 at Adly Mansour station, as well as connect the LRT to new urban expansions, specifically the New Administrative Capital and 10th of Ramadan city. It would also connect to the regional transport options at the same hub, connecting to other governorates.

The intention of this short-distance project is to showcase locally, even if on a partial basis, manufactured buses in a safe, appealing, and well controlled and easily monitored project. The fact that it is a short route points to the substantially *cautious* approach in rolling out electric buses that will be partially locally produced in Egypt, and to protect the branding of the buses in its first impression. It also promises the possibility to reduce battery size depending on the charging strategy and operational plan, saving on procurement costs. It is planned to be operated by *Superjet,* an operator of regional bus fleets. Although the road distance is approx. 15km (see Figure 2), the planned separate route mimicking a BRT is reportedly only around 3km in distance[21,22].

In summary, the 2014-2024 strategy of the Ministry of Transport has been set forth through the plan status of Q4 2019 and for 2020-2024, which includes all such ongoing or near-term projects. Much of the foreseen development is in electric rail, implying substantial increased demand for electricity that is currently available in excess.

Further implications of this mix are that although total consumption and carbon emissions are likely to continue increasing, the *share* of electricity consumption attributed to the transport sector will likely increase. This, along with measures to increase the share of renewables and decreasing the share of fuel-powered (ICE) vehicles, would together lead to reduced greenhouse emissions.

Decreasing dependance on diesel fuel is also a central theme although not aggressively pursued. However, with improved road conditions and planning of public transport with the eventual goal of integration of modes, developments in bus systems are being undertaken so that electric buses in trial today may be integrated into larger BRT systems in the future.

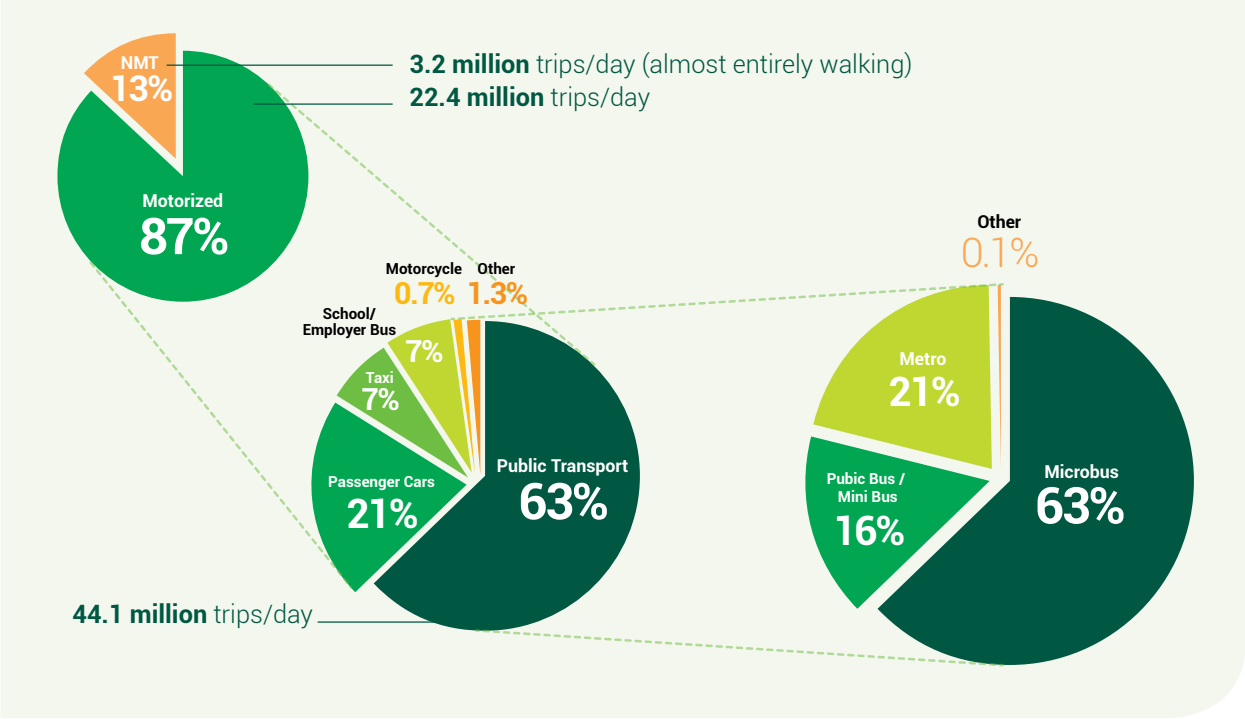
It is notable that attention to *last-mile* commuter experiences with public transport and mode-shift is still to be taken up for further development in Egypt. This includes pedestrian-friendly and cycling-friendly urban planning and integration in addition to other upgrades in the built environment. This might however come in later stages, as such concepts are gradually being introduced in the government's discourse.

Commuters and passenger transport

For most of the commuting and travel needs in Egypt, people depend on public transport, whether formal, semi-formal, or informal. Even as increased use of formal public transport is well underway, informal transport, such as 'tuktuks' (motorized three-wheelers) and microbuses remain essential. Micro vehicles such as Tuktuks, microbuses and 9-seat vans, continue to fill a large gap in mobility, especially in informal settlements that comprise up to two-thirds of Greater Cairo.

Figure 4: The regular route between Adly Mansour and Cairo Airport is 15km by car, but discussions are underway to construct an even shorter dedicated route served by electric shuttle buses mimicking a BRT

Figure 5: Mode split for Greater Cairo's 26 million trips/day in the latest update of 2014 (Source: Data from model-based update by Egyptian Transportation Centre of Excellence of the Ministry of Transport, 2014, adapted by CEDARE)

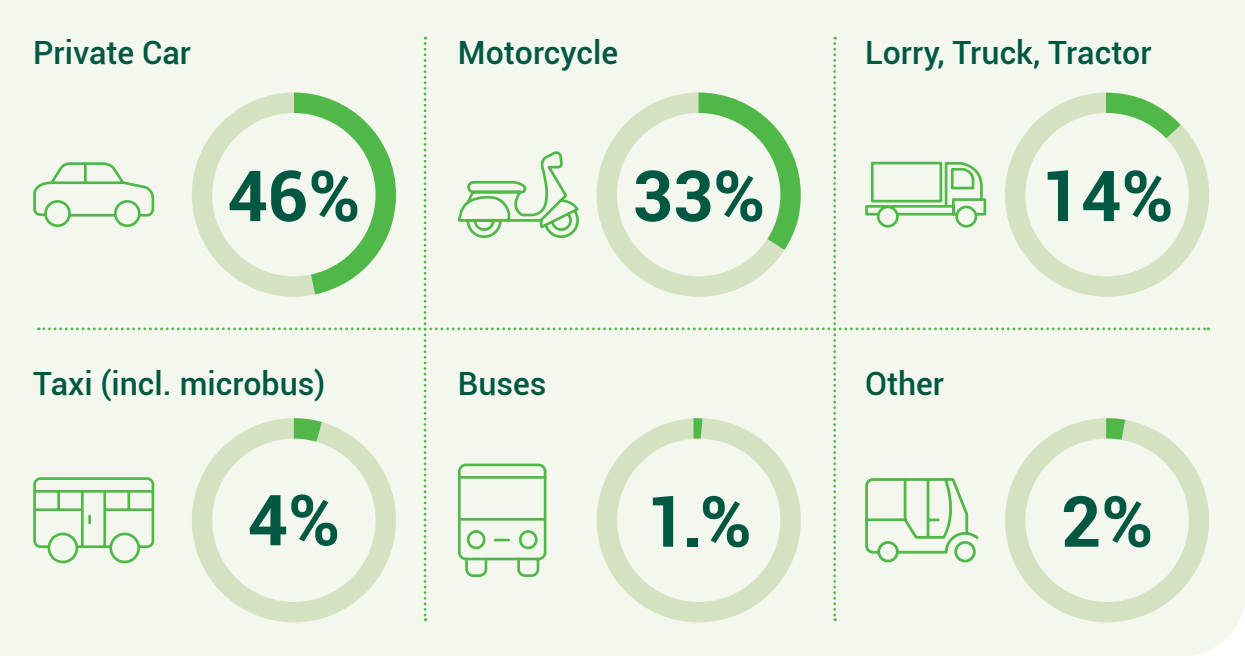


In other market segments, transport network companies including ride hailing services are also expanding rapidly, supporting the cultural shift away from vehicle ownership toward shared use.

Vehicles in Egypt

There are 11 million licensed vehicles in Egypt, almost half of which are private cars and a third motorcycles – exceeding 3.5 million[23]. Congestion, air pollution, and severe lack of public space in its cities are among the main challenges of sustainability.

Figure 6: Licensed vehicles in Egypt by type (source: CAPMAS, 2018)



A large portion of vehicles are aging vehicles exceeding 20 years of life. Accordingly, these are sub-par from several viewpoints, including environmentally. In 2009, schemes for replacement of light duty vehicles revealed that taxis older than 20 years consumed about one-third more fuel per kilometer compared to new vehicles. Savings today would be even higher due to improved technology. However, replacement and scrapping schemes have faced budget constraints, limiting their use to more types of vehicles, aging microbuses for example.

On the discussion about quality benchmarks in Egypt, those for gasoline are approaching European standards for fuels (Euro-2). But diesel is still far from such targets. Its hazardous sulpur content is discussed at length in the following section. Most diesel buses in the country are at best of *Euro-III* standards, i.e. lower in cost than the higher Euro standards. Notably, these do not refer to the Euro-III emission standard, but merely to the standard of the Euro-III vehicle procured. It is a common misconception to equate vehicle capabilities with emissions.

Since diesel buses in the country typically are of the Euro-III standard, and not the more expensive Euro-V or Euro-VI deployed elsewhere, CNG and electric vehicles come out being unfairly lot more expensive in terms of total cost of ownership with diesel buses. In reality, the cost of diesel buses is substantial. World Bank studies on the damage caused by air pollution indicated that it can cost upto approx. 1% of GDP in healthcare cost, also reinforced by other studies[24,25]. The consequent impact on tourism is also substantial. This is further discussed in the next sections herein.

A closer look at Diesel fuel and phase-out plans

An outlay of EGP 59 bn was allocated to subsidize petroleum products in FY 2019/2020, highlighting the substantial fiscal burden on account of fuel consumption that still remains[26]. Subsidy rationalization is however underway as part of Egypt's reform policies and is reflected in the steady increases in fuel prices. This is implemented in tandem with scaling up other more effective social protection programs.

Diesel fuel, colloquially kown as "Soular", specifically is a bigger burden than gasoline as it remains largely imported; about 50 percent of the need was imported in 2018/2019. Programs to move from diesel to natural gas fuel vehicles are in process. However, the rate of increase in overall fuel consumption may overshadow the move towards reducing dependance on diesel fuel. Therefore, projections for diesel phase-out and introduction of alternatives are fundamental in the current planning process, requiring relevant disaggregated fuel consumption trend data.

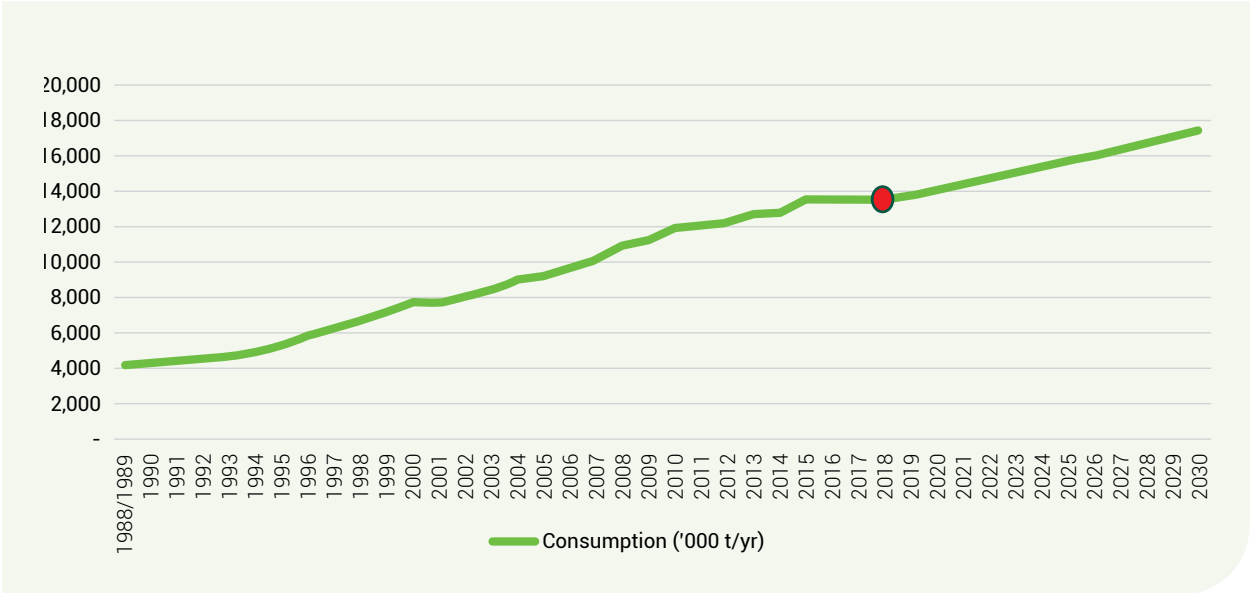
Accordingly, one of the key challenges in Egypt is addressing the low quality of Diesel as fuel in specific. Sulfur content is more than 100 times the international standards, exceeding 2600 ppm according to a 2019 study by CEDARE[27]. Sulfur is a catalyst poison; it inhibits the effectiveness of emission control technologies, resulting in increased vehicle emissions of carbon monoxide (CO), hydrocarbon (HC), nitrogen oxide (NOx) and particulate matter (PM), while resulting in Sox emissions by itself as well[28].

As a reference, Euro standards started with 500 ppm (Euro 2) in 1994, followed by further gradual reduction (350 and 50ppm respectively) to finally reach the latest imposed limit of 10 ppm in 2009 (Euro 5).

Worse, advancements in fuel efficiency in engines do not function well with high levels of Sulfur in diesel fuel. So purchasing high-standard vehicles does not result in the expected emission reduction and fuel savings without compatible fuel quality. In the meantime, diesel fuel consumption continues to grow rapidly with economic growth and increased fleets of public buses and micro buses.

The consumption of diesel fuel has almost doubled over years 2000-2015 (see Figure 5), while consumption of the public buses in Greater Cairo alone has doubled in the past 10 years, yet diesel quality has remained at hazardous levels to date.

Figure 7: Diesel consumption in Egypt up to 2018 and forecast consumption (sources: Ministry of Supply and Internal Trade; Egyptian General Petroleum Company, and CEDARE analysis)



Natural Gas and transition/conversion plans

In recent years, with vast discoveries of natural gas reserves in Egypt, most prominently in the Mediterranean Sea, the energy sector is experiencing a transformative change. Egypt achieved self-sufficiency in Natural Gas in 2018, witnessing an average production of 6.6 billion cf/day, meeting total domestic needs[29] .

Given the substantial dependence on imports to satisfy domestic diesel fuel needs, the government is seeking all viable opportunities to shift from diesel fuel to natural gas wherever possible, including in transport.

A national committee was established[1] in October-December 2018, to initiate a move towards clean fuel. This included potential policies requiring all taxis and microbuses (14-seater privately-owned transport services) to maintain or switch to a dual-fuel system – CNG and gasoline, or CNG and diesel. The policy aims to target the approximate 141,000 taxis and 98,500 microbuses that are still operating with conventional fuel, gasoline and diesel respectively, while considering electric vehicle alternatives in the longer run.

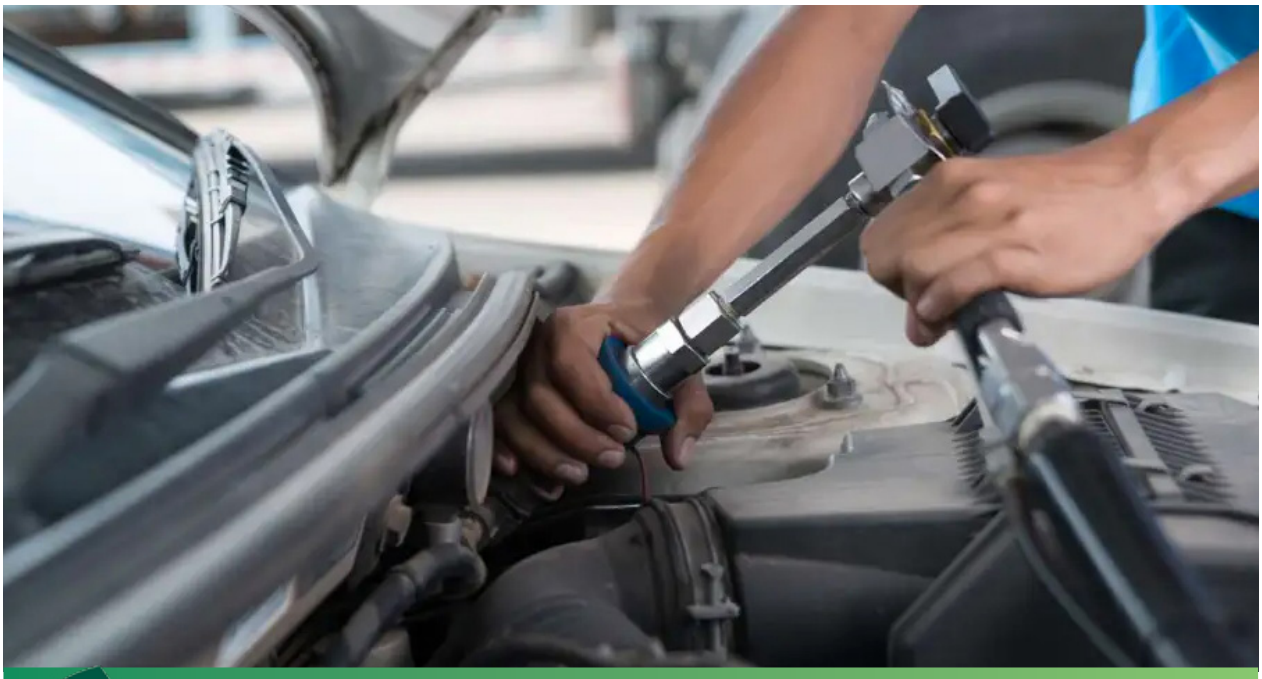
Subsequent plans under study include mainstreaming CNG use in public transport such as large buses, with plans to replace large portions of existing diesel-powered fleets. However, the continuing trend of rising diesel consumption is suspected to overshadow the impact of slow-penetration alternatives of CNG or electric vehicles, in addition to the time required for implementation. With adequate supportive policies to curb consumption of conventional fuels, such a scenario can be avoided.

Fuel and Electricity

The ministry of Electricity and Renewable Energy (MoEE) in Egypt governs the state-owned Egyptian Electricity Holding Company (EEHC) with its subsidiary production, transmission and distribution companies. The New and Renewable Energy Authority (NREA) under MoEE is primarily dedicated to advancing renewable energy and relevant new technologies.

The regulation of the sector is assigned to the Egyptian Electric Utility & Consumer Protection Regulatory Agency (EGYPTERA) formed as an independent entity regulating the sector, setting and monitoring standards, and setting tariff schemes.

There are no set tariffs for e-mobility in Egypt yet and charging costs are therefore dependent on the existing pricing schemes. Electricity and fuel prices are gradually being increased to reduce the burden of blanket subsidies. The table below indicates the prices of fuels and electricity relevant to the transport sector.



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1 The committee included all relevant public authorities' representatives as well as external experts, including CEDARE.

Table 2: Overview of fuel/electricity prices for vehicles in Egypt

Type	Price (2021)
Diesel	6.75 EGP/l (0.43 USD/l)
Compressed Natural Gas (CNG)	3.5 EGP/m^3 (0.22 USD/l)
Gasoline (92 Octane)**	8.0 EGP/l (0.51 USD/l)
Electricity (for EV charging)	1.45 EGP/kWh (highest tranche in residential sector, pertaining to >1000 KWh/ month consumption, currently serving electric cars) 1.65 EGP/kWh (case-based pricing for private operator e-bus trial)***

*Diesel fuel not compliant with any safe standards due to high Sulphur content (above 2,500 ppm, in contrast with 10ppm required for Euro-V standards), accordingly, Egypt it is noted that CNG is comparatively branded as 'Green' in consideration of substantial *local* pollution reduction.

** 92-Octane is included here for indicative purposes (80-Octane and 95-Octane also available), however all ICE Heavy Duty Vehicles use diesel fuel. Prices are subject to slight variation every quarter.

*** In the case of the first private operator to test electric buses, Mwasalat Misr, the price charged for a 6-month trial was 1.65 EGP/kWh (commercial rate) for the AC charging below 50kW. The price is provided here for indicative purpose since regulations are not yet set in place for charging prices.

Among some of the important potential elements to be considered in developing the charging infrastructure and pricing scheme are avenues for 'time-of-day' pricing, smart charging infrastructure to enable load-balancing and Vehicle-to-Grid functionalities, along with enabling incentive schemes.

However, a key prerequisite is an exhaustive grid-impact assessment study to examine needs for grid reinforcement for various electrification scenarios. This is a substantial challenge, especially in the existing metropolitan areas such as Greater Cairo and Alexandria, among others. Excess power production capacity is available, but the capabilities of the current grid are questionable until an exhaustive assessment of grid impact based on actual infrastructure data is available.

As an example, consider the plausible hypothetical scenario of 100 electric buses requiring overnight charging. This would need an approximate 5MW of power, which alone could pose a substantial challenge to the electricity *distribution* infrastructure in existing cities despite the availability of excess power *production*.

Higher penetration rates accordingly further emphasize the need for infrastructure studies in order to plan for scaling up existing pilot projects, along with tailored system-level solutions for prospective bus systems.

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A significant challenge to the switchover to electric vehicles remains the low diesel pricing, even with prospective gradual increments in coming years to phase out subsidies. Prices in EU countries, for example, are typically in the range of 1-2 USD/liter, about three times the prices in Egypt. With reference to the scope of this report, it is notable that prices in Jordan and Morocco are also approximately double of that in Egypt, as discussed later. CNG too is comparatively lower priced, which implies lower expected savings if replaced with electric power compared to diesel fuel.

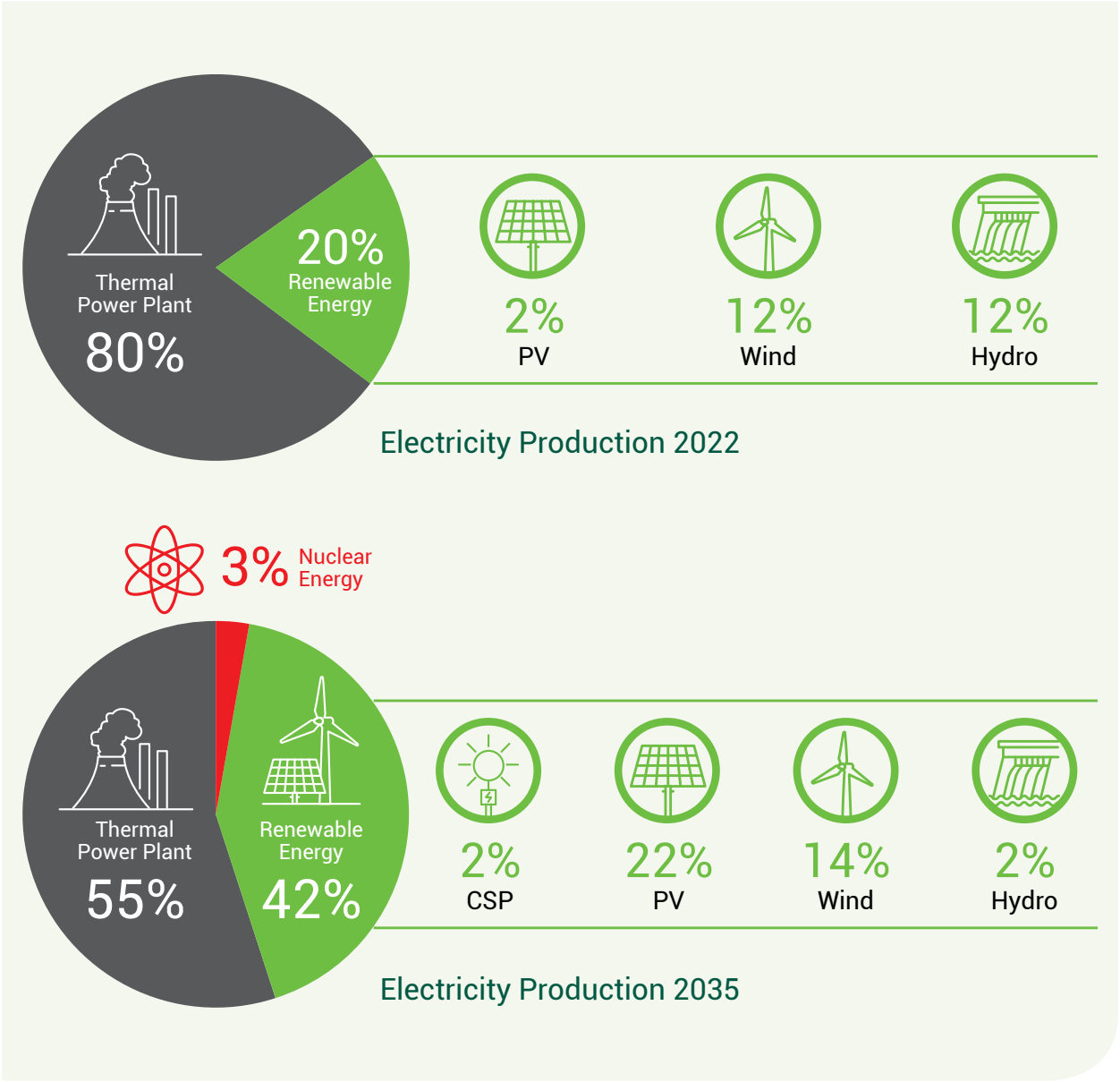
However, policy to support electricity-powered modes of transport can be introduced to partially incentivize e-buses; the reduced price set set at 1 EGP/kWh[30] is significant in this regard. This is in recognition of the positive social and environmental impact of this mode of mass transit, but the national agenda stresses the need to reduce subsidies and not introduce new forms. For other non-residential high-consumption users, there is simplified peak-hour charging scheme in place for ultra-high-, high-, and medium-voltages along with a capacity charge.

In conclusion, low prices of various energy sources continue to characterize the context in Egypt. This conversely implies a relatively higher sensitivity to the purchase cost of vehicles when compared to other countries where operational expenses are more steep.

Trend toward a cleaner power grid

Egypt's grid emission factor has been declining continuously. This is in large part due to shift toward cleaner electricity with the addition of planned efficient Combined Cycle Gas Turbines (CCGT) power plants in power generation, and expansion in new and renewable energy in the pipeline with a target of 42 percent renewable energy by 2035. However, with recent excess capacity in power production substantially exceeding demand, there is an implicit need to stimulate demand. Electrification in transport may therefore be the right answer here, helping catalyze a shift from the currently partially-imported diesel fuel towards electricity available in excess. This further magnifies the benefit of EV deployment when compared to conventional vehicles in all forms, including electrified rail-based public transport.

Figure 8: Energy mix in Egypt as disclosed by the Ministry of Electricity showing plans implying continual reduction in grid carbon emission (Source: New and Renewable Energy Authority, 2018 and 2019[31])



Although the figure above foresees substantial contribution of renewable energy in the future, the actual share in 2020 was less than 10 percent, suggesting limited possibility to meet targets on time despite being headed in the right direction. The grid emission factor, currently in the vicinity of 0.5 kgCO2/kWh, is expected to be decline gradually as thermal power plants of higher efficiency are introduced and the share of renewable energy is increased.

3.3 E-mobility in Egypt

E-mobility has been advancing in Egypt at a slow pace since 2013 with the first initial attempts for EV incentives in the form of custom duty exemptions for electric cars. Though these were maintained in the 2018 regulations, including permitting import of used electric cars, a decree by the Minister of Trade and Industry cancelled these in May 2021. Nonetheless, this long period of incentives has stimulated ad hoc entrepreneurial initiatives in assessing the market with used electric cars and piloting charging infrastructure concepts.

A stronger signal to the market came by way of the decision by the government in 2019 to commit to local development of EV manufacturing capacity and to support the enabling infrastructure and regulatory environment. This helped bring about greater organized private sector engagement and draw attention of development partners interested in supporting carbon-reduction projects. This was further supported with the mentioned decision to remove incentives for EV imports issued at the time of writing this report.

Policies and National Strategy for E-mobility

The current national priorities revolve around economic development, reform, and job creation, due to which e-mobility is viewed more as a driver of economic development rather than the environmental concern. E-mobility is therefore regarded as an opportunity for industrial development and improving Egypt's competitiveness through leapfrogging into producing new technologies.

Belt and Road Forum, 2019

In April 2019, an agreement was signed during the visit of the Egyptian President and his accompanying ministerial delegation to China on the sidelines of the *Belt and Road Forum,* including foundations for cooperation in EV production in Egypt.

Among the highlights of the visits, the Ministry of Military Production (MoMP) and Ministry of Trade and Industry (MTI) oversaw the signing of an agreement to specifically produce Electric Buses in Egypt. The agreement was drawn up between MoMP's factory *Harby-200* and the Chinese company *Foton Motor*. It aimed to lay the foundation for upgrading *Harby-200* facilities to jointly produce fully electric buses with 45 percent local components, targeting 500 units a year and eventually 2000 buses over four years. The MoMP also oversaw a Memorandum of Understanding between its affiliated National Organization for Military Production (NOMP) and Chinese automotive company *Geely* for the production of EVs at the NOMP facilities.

The Ministry of Public Business Sector is similarly attempting partnerships with leading manufacturers in China to capitalize on the existing capacities of the state owned *El-Nasr Automotive Manufacturing Company*[2] as well as the *Egyptian Engineering Manufacturing Company (EAMCO),* as evident in ongoing discussions with the China Association of Automobile Manufacturers (CAAM) and the exchange of country visits[32, 33]. It eventually led to agreements for manufacturing of electric cars at El-Nasr facilities in partnership with China's Dongfeng Motor[34]. The state-owned Arab Organization for Industrialization (AOI)[3] is also a key stakeholder of interest with potential production capacity[35].

National EV Strategy of Ministry of Military Production

The Ministry of Military Production came out with a national strategy for Electric Vehicles[36] in 2019. As a promising first step[4], this 15-page document focuses exclusively around vehicle assembly and manufacturing, specifically in cooperation with Chinese companies as noted already. It sheds light on the government's priorities and discourse. Key messages are summarized in the following aims and objectives:

- Position Egypt as a regional hub for electric vehicles manufacturing and developing feeder industries.
- Own 65 percent of EV manufacturing technology by 2030, increasing the market share of EVs in Egypt to 36 percent by 2030 and 50 percent by 2040, eventually aiming to be among the world's top exporters by 2040.
- Reduce fuel import dependence by 90 percent by 2040, reduce health and environmental damage costs, and boost industrial output contribution to GDP by 5 percent
- Establish necessary charging infrastructure – 3100 public charging units, and 400,000 private units – estimated ramp-up reaching 50 per cent of the expected growth until 2040, i.e 2 million electric vehicles.
- Increase grid capacity by 2040 to accommodate 403,100 charging units.
- Collaborate with Chinese companies – Geely Auto for passenger cars, Foton for city buses, and Ankai for highway buses.
- Pursue specific fleet electrification targets, including having 2 million electric vehicles in Egypt's vehicle stock by 2040, 400,000 private charging units by 2030, as well as a sizable number of public charging units.
- Assist, or merge with, the CNG-conversion program in Egypt to replace aging vehicles with electric as well.

Accordingly, planning and strategy development for E-mobility is at an early (learning) stage in Egypt.

2 Established in 1960, Nasr is Egypt's state-owned company and the first Arab vehicle manufacturer.

3 AOI is a state-owned organization established in 1975 primarily serving the defense industry. It is administered by a supreme committee chaired by the president of Egypt.

4 In the current circumstances of rapid development and limited time, it is common among certain public authorities in Egypt to report strategies in the form of brief illustrative documents that serve as both a manuscript and a presentation for the sake of practicality.

Strategy development support

Following the announcement of the government-led national strategy to promote electrification in transport, multiple entities from the community of development partners – multilateral development banks and other development organizations – are providing support in aiding development efforts and in building the enabling environment in various ways.

This support includes undertaking studies, building capacity, and promoting awareness (see Section 1.5). That is because access to accurate information and knowledge still remains a barrier.

An important aspect under discussion in policy development is enhancing emission standards for vehicles. This will imply higher costs of ownership for ICE vehicles, thereby improving the competitive position of electric vehicles. In most recent activity, CEDARE in partnership with the Friedrich Ebert Foundation and in cooperation with the Ministry of Environment, have initiated assessing the viability of Low Emission Zones (LEZs) schemes in Egyptian cities37. It is at the stage of 'introduction' of the concept to public authorities. The policy paper argues that there is substantial readiness to consider such schemes with advancements in fuel choices, fuel quality, and technology options including e-mobility, along with improvements in intelligent transport system infrastructure and ITS competences.

Figure 9: Advocacy of LEZs for Egypt

Alongside plans and efforts to develop the industry and market for E-buses, light-duty private electric vehicles are gradually penetrating the market. Electric cars and electric micro vehicles have been increasing in numbers, thanks to imports by small businesses and also by authorized auto dealers. This is gradually ensuring the industry prerequisites – after-sales services and adequate charging infrastructure. The industry is also poised to leap because of the promising prospects for local production initiated by the Ministry of Military Production with the Chinese OEM, Geely Auto, as well as the Ministry of Public Sector initiated with Chinese OEM Dongefeng.

No reliable estimates of the EV stocks are available in Egypt, but approximations by representatives of the advocacy community estimate around 1,000 electric cars to date, and a similar number for electric micro mobility vehicles. Almost all electric cars are used vehicles, benefiting from the custom duty exemptions offered for models that are three years old or less.

The policy environment in Egypt by 2020 was still under development to accommodate nation-wide rollout of EVs of various types, even as uncertainty persists about the charging infrastructure and tariffs, the ease of licensing vehicles, after-sales services, and so on. Beyond the aspect of advancing vehicle assembly and production, there is no holistic approach yet to strategy development.

Charging infrastructure and the enabling environment in practice

Since initial engagement by the private sector in 2018, the installed charging points in for e-cars in Egypt have exceeded 130, resulting in continued growth in 2020. This has largely come by way of AC chargers, with gradual introduction of DC fast chargers. There is substantial difference between charging infrastructure for cars and for prospective buses and gradual 'learning-by-doing' approaches have helped over time.

Initially, it was start-up company *Revolta Egypt* that had established a notable presence through collaboration with state-owned fuel distribution company, National Petroleum Company (NPCO) also known as *Wataneya,* to install EV charging stations at their gas stations. The first such station was launched in February 2018. Previous demonstrational charging points have also been tested at limited work places and shopping malls.

Next came another emerging Egyptian company, *Infinity-e, which* rolled out EV charging points at state-owned Chill-Out gas stations in select gated communities. The market is ripe for other start-ups installing charging points, but no tariff scheme is in place for such activity.

Developments in new urban communities are also increasingly considering charging infrastructure at the early stages of development, including evolving plans in the New Administrative Capital and the new Alamein City. State-run company Administrative Capital for Urban Development (ACUD), is mulling plans to provide charging points along the streets at regular intervals and in select destinations[38]. ACUD says it is also planning to install charging points along the streets at light posts so as to

The MoE study recommended exploring means to subsidize or incentivize the introduction of considerably higher-priced electric buses through climate finance, and to develop a pilot program for E-bus introduction

ensure widespread access and reduce urban clutter. Nevertheless, electric cars owners already predominantly charge at home. The public chargers provided by the private sector are mainly meant for promotional purposes so as to assure prospective EV owners about the support infrastructure.

A lot still needs to be addressed. The potential impact of charging electric vehicles on the power grid still needs to be assessed. The need for grid reinforcement has also not received attention from the government so far due to the limited stock of EVs and the uncertainty about widespread market uptake.

The successful widespread EV adoption in future, therefore, needs to focus on developing adequate infrastructure, which implies a carefully planned national strategy for charging infrastructure and grid reinforcement. It also needs to work on regulations, including setting the tariff scheme, setting standards and procedures for chargers to ensure safety, reliability, and interoperability, in addition to planning for electric heavy-duty vehicles.

Greenhouse Gas Reduction Potential and Local Air Pollution

A study was commissioned by the Ministry of Environment of Egypt to shed light on the GHG-reduction potential of electric busses in 2016. It indicated significant reductions in GHGs and local air pollution, noise levels, and savings in associated external costs by way of social impact on health and productivity. The quantified benefit was estimated to exceed 4 million USD a year for a hypothetical case study of 100 buses[39]. Well-to-Wheel energy savings were pegged at 12 percent, and carbon emission reductions at 28 tons a year.

In response, the MoE study recommended exploring means to subsidize or incentivize the introduction of considerably higher-priced electric buses through climate finance, and to develop a pilot program for E-bus introduction.

In a more recent appraisal of a project that is now under implementation by the World Bank, updated estimates of a pilot project of 100 electric buses have been found to translate into 444 tons of GHG as a result of fleet replacement as well as 4,251 tons as a result of *modal shift*, i.e. a total of 4,695 tons through the project life. This implies a sizeable 23 percent reduction[40]. Corresponding savings in social costs have also been estimated to exceed USD 250,000. The increase of renewable energy share in Egypt over time promises further reduction in the emissions from the grid.

The environmental and health damage costs, on the other hand, are humongous. Even though it is difficult to assess the damage costs of specific projects, studies for Greater Cairo give an indicative estimate at the mega-city level. Air pollution has been found to lead to environmental and health costs valued at 1.4 percent of GDP in Greater Cairo alone[41]. Furthermore, transportation is the largest contributor to local air pollution.

3.4 Legal and regulatory framework for bus fleets and systems

A key challenge in transport planning and improving on-road public transport services in Egypt has for long been associated with institutional fragmentation, misaligned roles and responsibilities, and difficulties in planning and coordination. This is however being addressed in recent attempts to consolidate planning and regulation mandates with the establishment of the Land and Transport Regulatory Authority (LTRA) in the Ministry of Transport in 2019.

The regulatory framework in place can be summarized as follows:

- Throughout Egypt, public bus systems are planned and regulated by the land transportation authorities in the governorates, which set routes and service requirements. They either directly operate public bus fleets or oversee and regulate operations. Public transport is significantly subsidized to ensure affordability. Despite gradual increases in fares, they do not cover operational expenses and imply a

substantial deficit for operators, even as overstaffing in government institutions weighs them down further.

- In the Greater Cairo Metropolitan Area specifically, within Cairo, Qaliubia, and Giza governorates, the public bus systems are managed and operated primarily by the Cairo Transport Authority (CTA) affiliated to the governorate of Cairo. The CTA both directly operates its own bus fleets, or otherwise oversees and grants licenses to private operators under the *Mass Transit Project*. Private operators mainly operate minibuses.

- In Alexandria, the Alexandria Passenger Transport Authority (APTA) affiliated to the governorate of Alexandria operates the governorate's public bus fleet.

- Furthermore, privately-owned 14-seat microbuses operated based on licenses granted by the governorate that set the route and fare scheme.

- The new Public Tenders Law No. 182 of 2018 (replacing preceding Law for tenders and auctions) regulates public procurement. The process involves giving priority to local suppliers and manufacturers, as well as aligning with the government's agenda for digital transformation through the use of the government's electronic public contracts portal.

- The Financial Leasing and Factoring Law No.126/2018, which governs financial leasing companies under the oversight of the Financial Regulatory Authority (FRA), has redefined financial leasing. It now also includes the lessee's right to buy the assets and excludes "operational leasing", which does not involve asset buy-out. It also excludes assets not needed for lessors' activity, be it manufacturing, services provision, or commercial.

- The Traffic Law 121/2008, overseen by the Ministry of Interior which grants vehicle licenses, does not recognize electric vehicles. But similar traffic and licensing regulations are being applied to e-buses until the law is updated and relevant regulations for e-buses are in place.

- An implicit indirect incentive in the Traffic Law is setting an age-limit of 20 years for all public vehicles, encouraging minimal vehicle replacement. Its enforcement is however stalled due to the lack of sufficient safety net measures for the affected stakeholders such as microbus owners and drivers. The law however is silent on how the old vehicles will be handled to ensure that the old inefficient technology is not reused elsewhere[42]. A taxi replacement scheme was implemented in the form of a vehicle scrapping and recycling program. But for buses, only limited demonstrational replacement programs have been initiated, that too for microbuses specifically.

Any discussion on promotion of EVs has to include laws and regulations affecting local manufacturing. It is a usually a choice between two options: incentivize imports to stimulate the market and raise awareness, or stimulate local manufacturing. The relevant policies and regulations in this regard are as follows:

- A notable disincentive for importing electric buses is the 40 percent custom duty in spite of full exemption for new and used electric cars. Exemptions for this duty can however be sought on a case-by-case basis, albeit through a lengthy process. This can be attributed to the use of Arabic terminology in the early phase of EV adoption. This is demonstrated in Table 2, where the items noted are indicated with the respective import tariffs imposed on electric buses (under HS code 8702.40) and electric cars (under HS code 8703.80). The Arabic translation of the word 'motor cars' is also used as the translation of 'motor vehicles' that include vehicles that carry 10 or more passengers as per the translated HS code nomenclature, which includes buses. Case-by-case exemptions are however sought for the time being, with the expectation that local manufacturing would suffice for future demand.

- Unregulated 9-seat vans and some unregulated microbuses also cater to a substantial portion of commuters, but these have to often face repeated attempts to ban, formalize, or limit their areas of operation to informal areas as a practical compromise.

Table 3: Custom duties for (a) fully electric buses, 40%, and (b) fully electric cars, 0% (in English and Arabic)

HS Code and description [En]	Import tariffs (%)	HS Code and description [Ar]
8702: Motor **vehicles** for the transport of **ten or more persons**, including the driver ... - *8702.40: With only electric motor for propulsion*	40%	8702: سيارات معدة لنقل عشرة أشخاص أو أكثر بما فيهم السائق. ... - 8702.40: مجهزة فقط بمحرك دفع كهربائى.
8703: Motor **cars** and other motor vehicles principally designed for the transport of persons (other than those of heading 8702), including station wagons and racing cars ... - *8703.80: Other vehicles, with only electric motor for propulsion*	0%	8703: سيارات ركوب (خاصة) وغيرها من العربات السيارة المصممة أساساً لنقل الأشخاص (عدا الداخلة فى البند 87.02)، بما فى ذلك سيارات «الأستيشين» وسيارات السباق. ... - 8703.80: سيارات أخر، مجهزة فقط بمحرك دفع كهربائى.

The Ministry of Transport (MoT) plans and develops Egypt's transportation megaprojects including the road network upgrades and various railway transport systems within and between cities. Among the challenges in Greater Cairo and Alexandria is ensuring coordinated planning with bus systems, which are under the regulation of the respective transport authority under the governorates.

Main financing models for Bus Systems

Options for innovative financial models can be contemplated for E-bus adoption in Egypt along the lines of all leading approaches. This includes models involving leasing solutions as discussed in global practices in Section-1.

For this, an assessment of existing financing models for the traditional bus systems is needed. Despite a gradual move towards increased privatization of services, an overall strategy and action plan for such a transition for public transport, whether at a city-scale or at the national level, is lacking. In the absence of a defined timeline and approach, government authorities plan and set the service requirements and quality standards, while the private sector operates and delivers the various services.

Most existing operational structures and financing models for conventional bus systems in the big cities are still in a transitional phase with varying degrees of private sector engagement. A few examples are given below:

- Greater Cairo (model 1): Cairo Transport Authority affiliated to the governorate of Cairo owns and operates bus fleets.
- Greater Cairo (model 2): CTA offers concessions to private operators and supervises the operators.
- New Urban Communities (East Cairo): New Urban Communities Authority (NUCA) offers concessions to operators, with emphasis on distance-based performance due to limited ridership in such areas.
- New Urban Communities (West Cairo): NUCA offers concessions to operators, with an offering of concessions for land plots available for revenue-generating commercial (and advertising) activity offered to the private sector operator.
- Alexandria: APTA of the governorate of Alexandria owns and operates bus fleets.

In all cases, the relevant public authority is the governorate, under the Ministry of Local Development.

3.5 Stakeholder assessment

This section presents public and private stakeholders and their relevant activity, whether in terms of mandates or practice, as well as the supporting organizations from the development agencies and MDBs.

Key public stakeholders

With a commitment to promote local production of electric vehicles in Egypt, a number of public agencies are mobilizing the country's facilities to engage in local production with international partners. The key stakeholders from the government side addressing electric mobility in Egypt are given below with their respective roles.

- The *Ministry of Environment (MoE),* through its executive arm, the Egyptian Environmental Affairs Agency (EEAA,) develops, plans, and strategizes for sustainable transport. This includes improving regulations to promote cleaner fuels and vehicular emission control, as well as accessing climate-funding for their activities and for other authorities. MoE also implements pilots or programs that can demonstrate replacement schemes for old taxis and two-stroke motorcycles, aging microbuses, in limited numbers.
- The *Ministry of Transport (MoT)* plans and develops Egypt's transportation megaprojects including the

road network upgrades and various railway transport systems within and between cities. Among the challenges in Greater Cairo and Alexandria is ensuring coordinated planning with bus systems, which are under the regulation of the respective transport authority under the governorates. Such coordination is part of the mandate of the newly established Land Transport Regulatory Agency (LTRA) within MoT to gradually pursue integration of transport services and ensure efficiency at a systems level.

The recent establishment of the LTRA aims to consolidate the previously scattered mandates of transportation planning in the Ministry of transport and other ministries. The executive regulations are yet to be issued, but current plans are focusing on planning advancements in Greater Cairo and connectivity with the New Administrative capital, with the following areas of activity tentatively planned: *(a) Automating licensing processes and engaging the private sector, (b) Advancing BRT systems, (c) Integrating Fares for the metro, monorail, LRT, and bus fleets of the CTA and leading bus operators, (d) Developing a vehicle inspection upgrade strategy.*

- The *Ministry of Military Production (MoMP)* developed, and continues to update, a strategy for EV production. It is leveraging its available production facilities of its *National Organization for Military Production* and is leading the national strategy development process for local production of EVs, mainly in partnership with Chinese OEMs (see section 0).

- The *Arab Organization for Industrialization (AOI)* is a state-owned Arab military organization also leveraging its available facilities and workforce to attempt advancing local production of EVs in a similar manner to the MoMP and also primarily in partnership with Chinese OEMs[5].

- *The Ministry of Public Business Sector (MoPBS)* manages state-owned companies and has been undergoing a substantial reform process to upgrades its assets since 2016. It is also engaged in attempts to mobilize resources to explore possibilities for partnering with technology providers to produce EVs in existing facilities – *El-Nasr Automotive Manufacturing Company*[6] and the *Egyptian Engineering Manufacturing Company (EAMCO).*

- *The Cairo Transportation Authority (CTA)* and *Alexandria Passenger Transport Authority (APTA)* affiliated to the governorates of Cairo and Alexandria respectively, and responsible for operating and regulating bus services and other public transport modes, are introducing cleaner technologies. They are piloting electric buses, but the main technology shift in the near-term is mainly towards replacing aging diesel-fueled buses with CNG-fueled buses. The CTA operates large (12m) buses, while private operators run minibuses under their supervision and regulation on concession-based agreements.

- The *New Urban Communities Authority (NUCA)* regulates bus services in new urban communities, which include new cities across Egypt and also new settlements in the periphery of Greater Cairo. As part of the eastward and westward expansion, a prospective Bus Rapid Transit Project is being planned in parallel independently from the MoT.

- The *New Administrative Capital* is a 170,000-acre project owned and developed by the *New Administrative Capital Company (NACC)* envisioned to be Egypt's new administrative capital. Located 35

The recent establishment of the LTRA aims to consolidate the previously scattered mandates of transportation planning in the Ministry of transport and other ministries

5 AOI is a state-owned organization established in 1975 primarily serving the defense industry. It is administered by a supreme committee chaired by the president of Egypt.

6 Nasr is Egypt's state-owned company and the first Arab vehicle manufacturer, established in 1960.

km east of Cairo, it is expected to generate substantial demand for transport services. The objective is to promote sustainable transport services through the promotion of EVs or CNG-fueled vehicles, or the provision of electric railway systems.

- The *Ministry of Electricity and Renewable Energy* aims to diversify Egypt's energy mix, increasing the share of renewable energy and providing the enabling regulations to that end. Two of its entities, the *New and Renewable Energy Authority (NREA)* and the *Egypt Electricity Regulatory Agency (Egypt ERA*), are the main players in this regard. Among other regulations, the ERA is responsible for setting the prospective tariff scheme for charging electric vehicles. Though it is still early days, the Agency is conducting studies with partners to strategize incorporating e-mobility into future plans for the power infrastructure and regulatory development. Among other challenges is the pressing demand by the automotive industry and bus operators for a clear vision for charging infrastructure and regulations. This is being gradually developed. Furthermore, under the Ministry, the *Egyptian Electricity Holding Company (EEHC)* is responsible for governing generation, transmission and distribution.

Other stakeholders likely to be involved in the development of e-mobility in Egypt are:

- The *Micro, Small, and Medium Enterprises Agency (MSMEDA)* is a public agency affiliated to the Ministry of Trade and Industry (MTI) dedicated to advancing entrepreneurship in Egypt among MSMEs. This includes developing and implementing programs for providing a range of financial solutions, including microcredit projects. It is experienced in financing CNG vehicles conversion programs and has renewed its support in 2020 with a new financing program designed to finance conversion of taxis, passenger cars, and microbuses through a scheme involving replacement, scrapping, recycling of vehicles that are 20 years old. Replacement with electric vehicles is not yet part of near-term plans due to concerns about feasibility, but foreseeable as EV prices decline.

- Other authorities of relevance are the Ministry of Finance, Ministry of Planning, Ministry of Petroleum, Ministry of Communication & Information Technology, and the Ministry of Investment.

Key private sector stakeholders

Charging infrastructure entrepreneurs

Several players have been rolling out charging stations for cars, mostly in collaboration with gas stations and with key destinations such as malls. Relevant standards and a tariff scheme are not yet in place, as a result of which operators are currently pursuing own standards and business models, including free charging as a promotional practice.

Elsewhere, charging for buses has been provided for by the Original Equipment Manufacturers (OEMs) together with the electric buses as in the case of BYD in Alexandria. This is discussed in detail in Section 1.8.

Private bus companies providing public transport services

Under the supervision of the CTA, more than 20 private bus operators have deployed fleets of minibuses. A key private operator exploring e-mobility options is *Mwasalat Misr,* discussed in detail as a case study in Section 1.7. It is also an exception in that it additionally operates large 12-m buses, similar to those operated by the CTA. Mwaslat Misr piloted the operation of an electric bus for over 6 months in 2019 with satisfactory results, but a client could not be secured partly due to the high upfront cost.

Elsewhere, another noteworthy emerging player is *SuperJet,* which is operating regional buses originally catering to international transport services among neighboring Arab countries. Today, it mainly provides inter-city transport. It has been named by the Minister of Transport to provide electric shuttle buses between the Cairo International Airport and the Adly Mansour transport hub.

Ride-hailing services

Ride-hailing companies catering to buses such as UberBus, CareemBus, and the Cairo-based SWVL have substantial presence in Egypt but no announced plans to pursue electrification of vehicle fleets. The users however are growing in numbers with hundreds of routes mostly in Cairo and Alexandria, which positions these companies as a significant stakeholder in Egypt's move towards cleaner fleets.

Although none of the ride-hailing companies has announced pursuit of cleaner fleets plans in Egypt, an initiative by SWVL in partnership with Ford in 2019 is a good example of incentivizing vehicle *choice*. As per the partnership agreement, *Ford Transit minibus* would be promoted as the "preferred vehicle of choice" on SWVL's routes[43]. These minibuses are to be of 15-seat and 18-seat configurations. Accordingly, SWVL also partnered with Nasser Social Bank and EFG Hermes Bank to offer competitive lending rates to operators choosing Ford Transit bus as their vehicle of choice. Support to bus operators also includes after-sales support and maintenance services by Ford-trained technicians through the network of the local distributer, Auto Jameel.

Other private bus companies and fleet operators

Other key players are private bus fleet owners and operators, including companies providing B2B services, such as those catering to schools, universities, gated communities, and gated business districts. There are also various other fleet owners and operators in the tourism industry providing inter-city transport, or offering rental services. Travco, Go-Bus, Blue Bus are a few examples. A project was launched in October 2020[7], as part of which

7 In 2018, Orascom Investment Holding (OIH) signed a contract with the Supreme Council of Antiquities (SCA) to provide and operate the facilities at the Giza Plateau.

A key theme throughout CEDARE's discourse has been the fundamental requirement to improve fuel quality, diesel fuel specifically, alongside other measure to improve air-quality. E-mobility is therefore positioned as a secondary priority in terms of local air pollution and public health.

a leading mobility company, *Family Corporation*, was solicited by *Orascom Pyramids Entertainment* of Orascom Investment Holding (OHI) to provide an electric bus service on the multi-stop route between the Visitor Center and the Pyramids complex.

Major local bus manufacturers

Other than the state-owned companies and organizations assembling and manufacturing buses, there are several leading private-sector local manufacturers and assemblers of buses, including *Manufacturing Commercial Vehicles (MCV), GB Polo (Ghabbour Auto and Marcopolo)*, and *MAN-KASTOUR*. These are all joint ventures between Egyptian companies and international OEMs as well as Geyushi Motors.

Notably, *Geyushi Motors* has initiated diesel-to-CNG retrofitting with the aim to replace around 10 percent of the CTA buses each year. Geyushi and Chinese manufacturer *Yutong* have also introduced a new CNG mini bus (24-seater) in the market. Another company, MCV, has already demonstrated in the market its offering, fully-electric C120 bus, showcased in the *TransMEA* transport fair and forum for the Middle East and Africa in November 2019. In other words, even though the local industry is at an early stage, it also caters to international markets, which may justify investment into developing local capacity for EV production in the country.

CNG transition stakeholders

Important stakeholders in planning shifts in bus technology are the companies providing CNG conversion services, in addition to CNG stations and fueling infrastructure and services. Some of the notable names are those of *Car Gas* and *Gastec,* affiliated to the Ministry of Petroleum, as well as *Master Gas,* a subsidiary of Taqa Arabia. The national agenda for shifting bus technologies to run on CNG is seen to also stimulate the local economy due to the availability of competence and know-how locally and the possibility of immediate implementation, building on past experience with taxi replacement programs and availability of established technologies.

Key Development Partners

Several development partners are working towards planning and implementation of sustainable transport projects, which range from support in research, to policy making, to technical and financial assistance in various forms.

- The Center for Environment and Development for the Arab Region and Europe (CEDARE), as an intergovernmental not-for-profit organization based in Egypt, provides various forms of support for the e-mobility stakeholder community. It has been providing policy support and assisting the government of Egypt through MoE in planning for advancing electric mobility since 2016. The Center is working with a wide range of partners – primarily the Friedrich-Ebert Foundation and the UN Environment Programme. The objective is to pursue a holistic approach to sustainable mobility that goes beyond vehicle technology. It includes a gamut of initiatives, including urban planning, cleaner fuels, and so on, while addressing low-carbon development and mitigating air pollution. CEDARE also facilitates coordination and communication with local stakeholders and facilitates learning from international players stakeholder engagement. Among the potential topics of policy support are Low-Emission Zone (LEZ) development in Cairo and other areas suffering high air pollution. This in turn would help promote electric vehicles. A key theme throughout CEDARE's discourse has been the fundamental requirement to improve fuel quality, diesel fuel specifically, alongside other measure to improve air-quality. E-mobility is therefore

positioned as a secondary priority in terms of local air pollution and public health.

The European Bank for Reconstruction and Development (EBRD) has been conducting a Market Strategy and Market Study in Egypt that was originally due in 2019. The study would shed light on the market potential and investment opportunities for various types of electric vehicles and charging infrastructure, including its impact on the grid. This would provide support to the Ministry of Transport and Ministry of Electricity and Renewable Energy in strategy development.

The EBRD is working on a Green Cities program since 2016 that helps cities invest in sustainable municipal infrastructure. It assists in developing Green Cities Action Plans (GCAPs), facilitating sustainable infrastructure investment in various sectors. In addition to Amman, Jordan, cities in the MENA region include Alexandria and Cairo (excluding Greater Cairo) in Egypt. The program also implies enhancing capacity and possibilities to attract donor co-finance where necessary.

- The World Bank has initiated a USD 200-million loan project in Egypt named *Greater Cairo Air Pollution Management and Climate Change project (2020-2026).* It addresses air pollution management, waste management, transportation, and public awareness. Of the outlay, USD 40-million has been allocated to the transport component: *The Electric Buses Demo Project*. It includes procurement of 100 electric buses and associated infrastructure and capacity-building. The counterpart is the CTA. Elsewhere, in coordinated activity, a study to investigate scale-up needs in Egypt, Jordan and Morocco has also been announced and scheduled to be concluded by Q4 2021.

The World Bank has initiated a USD -200million loan project in Egypt named Greater Cairo Air Pollution Management and Climate Change project (2026-2020). It addresses air pollution management, waste management, transportation, and public awareness

- The Egypt office of the United Nations Human Settlements Programme (UN-HABITAT), together with partners including the Institute of Transportation and Development Policy (ITDP) in Egypt, has been advocating sustainable mobility. This includes focusing on policy support and technical assistance to advance bus systems in cooperation with the Ministry of Housing and its New Urban Communities Authority (NUCA). The concept of Bus Rapid Transit (BRT) specifically is central to the advocacy and support activity, including workshops and awareness-raising, preliminary studies, and policy support. The thrust of the studies is on linking new urban communities with the central business district, currently at an early stage of planning. A key recommendation is the need for a dedicated BRT Agency (hybrid public-private structure) beyond the constraints of one governorate. Choice of bus technologies would come at a later stage as part of the mandate of such entity.

- UNIDO, another specialized agency of the United Nations that assists countries in economic and industrial development, is globally supporting strategy for creating the enabling environment for e-mobility and associated industrial development. This includes roadmap development, support for credit-worthiness of municipalities, piloting centers of excellence and implementing demonstrational projects, and in some cases, specific targeted interventions, such as linking value-chains to secondary-use of batteries, and so on. Much of the recent activity is in the context of the GEF Global Program on Electric Mobility coordinated by UN Environment. Egypt is not yet among the participating countries. However, discussion of city-level support interventions is under way, part of which includes advancing electric mobility among other elements of sustainable cities.

- The Egyptian-German Joint Committee on Renewable Energy, Energy Efficiency and Environmental Protection (JCEE) is working on a project of the German development agency, GIZ, spanning through 2019-2023. It aims to advance sustainable energy infrastructure and is led by the Ministry of Electricity and Renewable Energy (MoERE) as the executing agency. Among the activities, studies are under way to assess the needs of the power sector and the regulatory framework to accommodate foreseeable ramp-up of EVs. For this, guidance is aligned with international best practice is provided at the conceptual level, and a regulatory framework and tariff scheme is advocated that would allow peak-shaving and load-leveling.

Among the challenges in the overall discourse, the most formidable one is about the comparison of conventional ICE vehicles with the electric ones, in place of infrastructure requirements or system-level comparisons of fleets and corresponding infrastructure configurations.

The future themes of cooperation in e-mobility are therefore expected to venture further into the infrastructure aspect, including comparison with infrastructure required for ICE vehicles.

International Cooperation

In 2020, the transport sector secured the largest finance through official development assistance garnering a total funding of USD 1,794 million. Significantly, the Ministry of International Cooperation (MoIC) has ensured alignment with the United Nations' Sustainable Development Goals SDG 8, 9, 11, and 17, as asserted in its 2020 report[44].

Among the multilateral and bilateral Development Partners providing finance for the transport sector, are the EIB, AFD, EBRD, and the Kuwait Fund for Arab Economic Development =(KFAED). Bilateral cooperation with China is yet another avenue. The funding is divided among six major public transport projects, mainly in railways, while support to the national roads project is also continuing. The World Bank is supporting the component of electric buses in the project, *Greater Cairo Air Pollution Management and Climate Change*, but it is categorized under the *environment* sector, indicating its primary objective of addressing environmental challenges.

Other relevant projects include those in the electricity and energy sector, but none explicitly addresses the potential needs for EV charging infrastructure.

Institutional Capacity

In review of the mandates and actual activities of the key stakeholders, it is clear that the institutional capacity to develop projects for electrification of bus systems in Egypt is challenged by the fragmentation and overlap of roles and responsibilities.

The Cairo Transit Authority (CTA) and Alexandria Passenger Transport Authority (APTA), for example, continue to operate substandard buses, causing high air pollution in the city. Even as bus systems remain without planned bus stops and schedules, other public transport projects in the city can be directly superimposed through the Ministry of Transport without the necessary coordination. This leads to overlaps in routes planned in projects by the Ministry of Housing, through NUCA. Plan for BRT in the east side of Greater Cairo is one such example. As a result, projects are superimposed without the required coordination in an integrated strategic plan.

Therefore, there is a pressing need to gradually converge towards the development of an overarching entity that will sustainably oversee planning of urban mobility. This has been attempted several times before, the last attempt of which is the establishment of the LTRA, but such an institutional reform has not translated into actual practice. To cite an example, LTRA does not have the sufficient power and budget to meet the mandates it was assigned. For electrification of buses specifically, and given the mandate to promote local production of electric buses, an inter-ministerial committee for electric buses and infrastructure is required. For this, the distinction between the requirements of private cars and those of bus systems needs to be emphasized for the benefit of planners and policy makers.

3.6 Market overview and situation analysis

The public bus systems market in Egypt has several factors going for it. The reasons for the private sector to find it lucrative for engagement are many. Egypt is a growing economy with increasing demand on mobility services, existing vehicles are aging and require replacement,

Egypt is a growing economy with increasing demand on mobility services, existing vehicles are aging and require replacement, schemes for vehicle replacement are already in place although currently favoring the CNG alternative, the regulatory developments are in a trajectory that will increasingly cater to private sector engagement

schemes for vehicle replacement are already in place although currently favoring the CNG alternative, the regulatory developments are in a trajectory that will increasingly cater to private sector engagement despite the barriers faced to date, and the political will to adopt state-of-art technology is evident.

Importantly, only a small portion of the stock of buses, about 10 percent, is being used for public transport systems in Egypt, implying significant opportunities beyond public transport services. However, since high-usage vehicles are more likely to meet relative cost-parity, it is precisely public transport vehicles that will be pivotal in the transition to e-mobility.

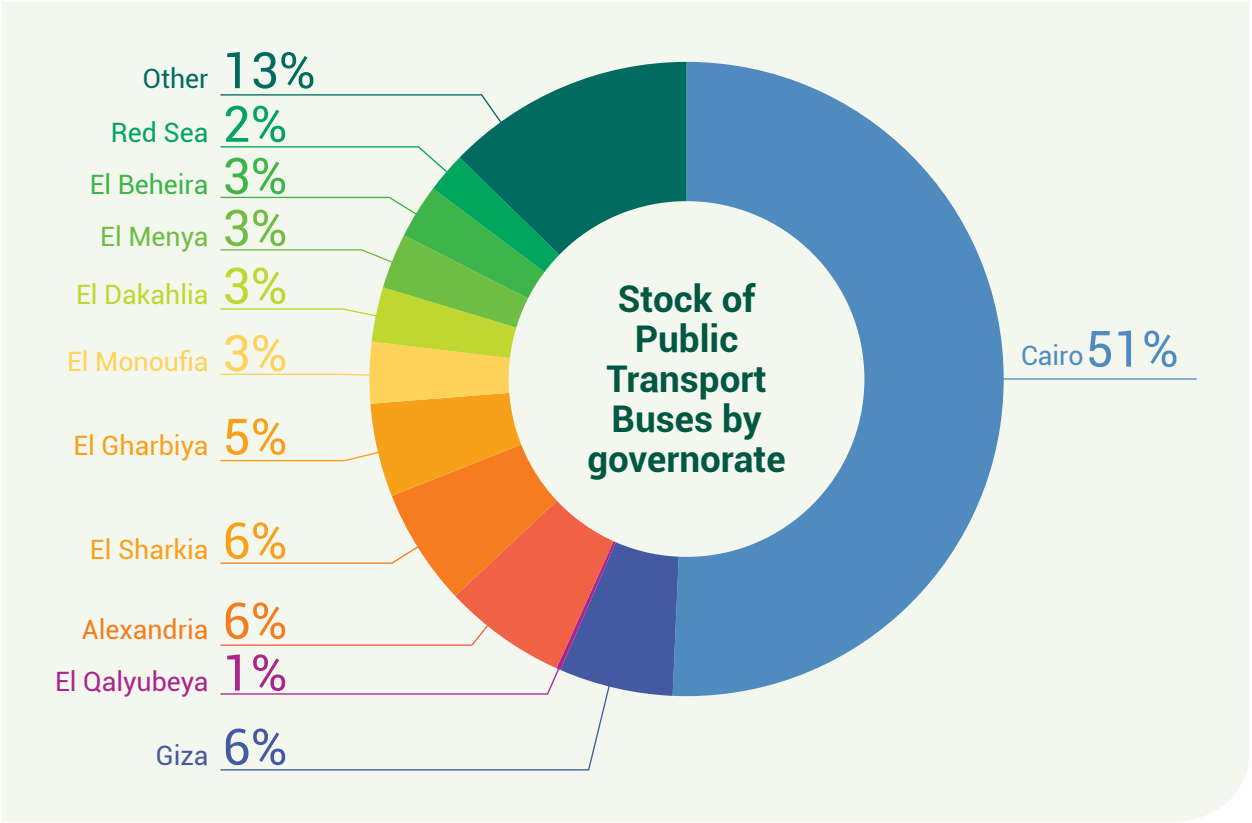
Opportunities continue to abound beyond buses catering to public transport services. Key examples of other use cases include Fast Moving Goods and Beverages (FMCGs) fleets; tour operator fleets and other inter-city bus fleets; shuttle bus operator fleets catering to schools, universities, gated communities, industrial zones and gated business districts; and fleets serving various government agencies, among others.

Market size and competition

Apart from shared taxis, better known as microbuses, the bus fleets used in public transportation in Egypt are predominantly aging diesel buses of various sizes ranging from 12m, 9m, to 7m lengths; new buses are incentivized to be CNG-fueled.

There are approximately 160,000 buses in Egypt with a compound annual growth rate of 4 percent over 2014-2019. These are licensed for use as either Public, Private, Tourist, Travel, or School transportation. Most licensed public buses are in Cairo as noted in Figure 10.

Figure 10: Stock of Public Transport Buses by governorate



Of the total stock of buses, 10 percent (approx. 16,000) are dedicated to public transport by license type[45]. Half of this, or approx. 8,000 buses, are in GCMA. Just about half of the last number are in regular operation as discussed in the following section.

Public transport bus fleets

Although data indicates substantial numbers of buses in the total vehicle stock in Egypt, the number that is actually *operational* is significantly small. In GCMA, only about half of its licensed public transport buses are in regular operation, distributed in ownership between the CTA and the concessionaires. This amounts to an estimated 4,000 buses in regular operation in public transport in GCMA, along 315 routes in place.

Until Q2021 2, there was no apparent planning to integrate the potential high power demand of electric buses into the future plans of the power sector and develop the necessary tariff scheme. However, the announced plans for ramping up manufacturing of electric buses and introducing a sizable fleet of electric buses (100 buses) in cooperation with the World Bank will likely catalyze such planning.

The CTA directly operates fleets of 12m buses, and oversees 23 operators that operate the rest of the operational stock, predominantly of smaller sized, 9m and 7m, buses.

In Alexandria, the second-largest urban area, APTA operates a fleet of 239 operational buses in addition to 15 new 12m electric buses. This has been further discussed as a case study in Section 1.8.

"Go Green" Vehicle Replacement/RETROFITTING Program

After extensive preparations for a vehicle replacement scheme targeting regular taxis, microbuses, as well as private cars, a "Go Green" exhibition was formally launched to kick off the transition in January 2021. The vehicle replacement scheme aims to support the conversion of current diesel and gasoline- fueled vehicles to use CNG, aiming to support the enforcement of the age limit of vehicle-licensing of 20 years as per current laws.

The program aims to convert or replace 250,000 taxis, private cars, and microbuses to use natural gas primarily (dual-fueled) in the initial phases as per the announcements of the Ministry of Trade and Industry and the programs official page[46].

There are an estimated 270,000 microbuses in Egypt in 2020, of which 15,000 microbuses will be replaced in 2021. CNG fueling stations will accordingly be constructed to meet the expected demand.

Even though there is a pressing need to set up new CNG fueling stations, existing CNG bus fueling stations in Cairo and Alexandria already have under-utilized capacity that can be used for fuelling hundreds of buses per day. This will help secure immediate needs until further infrastructure is expanded. The 'green' initiative will help lower local pollution emission from CNG as compared to the vehicles replaced.

Charging infrastructure for E-Buses

Until Q2 2021, there was no apparent planning to integrate the potential high power demand of electric buses into the future plans of the power sector and develop the necessary tariff scheme. However, the announced plans for ramping up manufacturing of electric buses and introducing a sizable fleet of electric buses (100 buses) in cooperation with the World Bank will likely catalyze such planning.

Currently, e-buses being piloted are subject to risks of limited grid capacity and limited local competence to ensure safe charging. Uncertainty abounds about future power tariffs, given the typical charging requirement of 50kW or less, unprepared infrastructure, and a default tariff of 1.65 EGP/kWh in the highest segment[8] of commercial activity. In the absence of the grid reinforcement need for prospective buses under different scenarios, the government's plans for preparing the necessary infrastructure are still unclear. It is largely because e-bus trials in Egypt have been implemented in an ad hoc manner, and not as part of a systematic process.

8 Confirmed through direct communication with private operator Mwaslat Masr.

Considerations for total cost of ownership evaluation

Findings of global case studies indicate that the gap in Total Cost of Ownership (TCO) between electric buses and ICE buses is closing, but it continues to be highly sensitive to the context of each country or city. This is largely in terms of procurement costs and associated taxation or incentives, competing technology, energy prices, among other aspects.

In the case of Egypt, the following key factors and considerations will affect the TCO analysis when exploring the life-cycle cost parity:

- When comparing with diesel-fueled buses, e-buses should ideally be compared with *Euro-III* diesel buses because higher Euro standards are not applicable in Egypt due to the lack of low-Sulphur diesel fuel. This is nevertheless a conservative comparison since Euro-III diesel buses shall not be procured in the future unless sufficient CNG-fueling infrastructure is not made available as planned.

- Therefore, comparison should primarily be made with CNG-fueled buses. This is more relevant in the case of Egypt because of the national strategy of procuring CNG buses in future. Even though substantially more expensive than diesel buses, this in turn favors electric buses in life-cycle cost parity analysis. Conversely, the lower cost of CNG fuel compared to diesel in Egypt will work to the advantage of CNG buses.

- Given the potential local manufacturing of electric buses, the upfront costs of electric buses may significantly be lower in the foreseeable future than the cost of imported electric buses considered today (2020/2021) according to the national strategy for local manufacturing.

For *indicative* purposes, a simplified comparison can be made between CNG, diesel, and fully electric buses with ranges above 300km, assuming 10 years of operation, and a conservative consideration limited only to the fuel costs in Egypt. An incorporation of maintenance costs, which is not included here, would further favor electric buses.

A comparison of plausible choices of a fully electric bus with a comparable Euro-III diesel bus would imply approximate TCO parity, based on procurement costs and energy costs for a distance of about 800,000 km over 10 years of operation. However, if compared to CNG buses, TCO parity is lower due to the low price of CNG fuel, leading to comparable costs per kilometer traveled. The infrastructure costs are not factored in such comparisons in Egypt and thus warrant detailed analysis.

If diesel buses that are cheaper and of lower quality are considered, TCO parity would be even more difficult. This highlights the importance of setting higher standards for diesel buses in Egypt. It is a challenge due to the low-quality high-sulphur fuel available, but foreseeable in the future as fuel improves. Furthermore, future in-depth feasibility studies must also include the maintenance cost differences and a possible battery replacement over the time-range of comparison (typically 10 years), maintenance cost of CNG buses, among other case-sensitive considerations[9]. These factors require in-depth data collection for more detailed feasibility studies, and should also include the noted infrastructure costs.

A promising highlight in this regard is Egypt's move towards CNG buses, significantly more expensive than diesel buses. The cost is one-and-a-half times in the case of 12m buses, and double when compared with the lower Euro-II diesel buses. Considering that CNG is the "business-as-usual" baseline for TCO parity analysis in Egypt, this would therefore favor electric buses if/as fossil fuel prices increase and electricity prices for charging EVs are maintained or lowered as an incentive.

A 12m fully electric bus available in the market can be approximately 14 percent more expensive than the cost of a CNG bus as per the case studies indicated in Table 3.

Table 4: Indicative costs of 12m-bus examples – Diesel, CNG, and Fully Electric

Fuel/energy type	Manufacturer*	Bus Cost (EGP)	Energy price	Efficiency	Energy cost (EGP/km)
Diesel	Kastour	2,500,000	6.75 EGP/liter diesel (0.43 USD)	55.0 l/100km	3.71 (0.24 USD)
CNG	MCV	3,700,000	3.50 EGP/m^3 CNG (0.22 USD)	45.0 m^3/100km	1.58 (0.10 USD)
Fully electric	MCV	4,200,000	1.65 EGP/kWh (0.11 USD)	106** kWh/100km	1.75 (0.11 USD)

** The 12m-bus examples are based on (a) Diesel bus (Euro-III) of Kastour, (b) BEB of MCV (C120-EV) of >300km range, (c) CNG of MCV (C120).*

***Due to lack of on-road data for the MCV bus in Egypt, the efficiency noted for the electric bus operation in the Egyptian environmental conditions is obtained through a 6-month on-road test conducted by Mwaslat Masr in Egypt with a bus of similar technology and battery capacity and specifications. Other efficiencies for the CNG and Diesel buses are obtained through the Ministry of Transportation, the CTA, and Ministry of Military Production.*

9 Approximations noted here for indicative purposes only and comparisons, and assuming a battery warranty of 10 years.

A difference of 500,000 EGP points to the need to develop an incentive scheme that can provide price differences to private operators if adequate regulation and planning for infrastructure is in place.

Further scenarios to favor electric buses include the consideration of salvage value of batteries, as well as charging *strategies* translating into operationally cheaper buses with improved 'rightsizing' of batteries. Other potential factors favoring electric buses are reduced downtime, among other known advantages of less maintenance costs.

3.7 Case study: Mwasalat Misr

Despite lack of a government strategy to incentivize the market uptake of electric buses among private sector players, bus operator Mwasalat Misr has conducted a trial operation of an electric bus as a proactive measure.

Background: Mwasalat Misr

Mwasalat Misr, initially Misr Bus, was established in 2011 with EGP 150 million paid-in capital and EGP 3 billion of authorized capital. By December 2020, the company was operating a fleet of 160 city buses and minibuses in Greater Cairo, serving the new areas to the east and west of the city –Sheikh Zayed and New Cairo settlements respectively.

The company started a fleet of high-end buses in 2014, characterized by air-conditioning, screen displays, Wi-fi access, among other things, substantially differing from the conventional buses back then. It mainly targets the 'B+' to 'B-'class of clients who are willing to pay more for better quality. After running services successfully, the company carried out organizational restructuring with assistance from international development agencies to further enhance the company.

In 2015, the *Emirates International Group (EMG)* partnered with the company to form a joint venture, acquiring 70 percent of the company stake and naming it *Mwaslat Masr* as known today. It is today a holding company of 4 subsidiaries – Al-Heba for Public Transport (AHPT; for new settlements), Cairo for Public Transport (CPT), and the newer subsidiaries, Tansmedia, for advertising, and Easy Mobility, for ITS services.

Project: X-Bus

Aiming to be a first-mover in Cairo with regards to electrification of buses, Mwasalat Masr sought to collaborate with suitable OEMs to pilot electric buses in Egypt. Chinese company *Shanghai Wangxhiang Automobile Co., LTD*, of CCI Holding Group was concluded as their partner of choice. They also discussed with the Arabi Organization for Industrialization (AOI) opportunities of local assembly to ensure future prospects are aligned with the national agenda for localization of production.

Mwasalat Masr calculations on TCO (Total cost of ownership) have led the company to conclude that electric buses do not compare favorably with other technologies – CNG-fueled or Euro-III diesel-fueled – that are being adopted for new buses in Egypt. Therefore, subsidies and concessionary loans are still needed for private sector participation.

Nonetheless, the plan for the trial operation was pursued as an act of stewardship, in addition to expressed interest from a prospective client, the New Administrative Capital Company (NACC).

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Experience and Results Evaluation

The first electric bus was delivered from China to Egypt in late 2019 for a 6-month trial in cooperation with the AOI and Mwaslat Masr. It was a result of the liaison with *United Investment*, local dealer of Wanxiang Automobile Co. LTD. The bus, *Pure Electric Bus Wanxiang SXC6129GBEV,* chosen for the trial was tested throughout December 2019 – March 2020. It operated for 12,000 km, mostly with satisfactory results barring few minor concerns.

A summary of key specifications are as follows:

- Size: 12 meters, 44 passengers
- Battery: 314 kWh Lithium Iron Phosphate battery
- Range: 250 km with A/C (300 km without A/C)

The testing and reporting investigated the following aspects:

- Driving range (maximum range and association with state of charge (SOC))
- Battery charging discharging performance and actual electricity consumption
- Driving performance

Monitoring was conducted using the available bus instrument cluster and charge monitor, and the operation routes in the trial included the following routes:

(a) The 6th October city (flat route), and

(b) The M5 route of Tahrir to the 5th settlement (slightly uphill and back).

The bus was charged through overnight charging (50kw). Some of the main concerns included low floor-clearance, high center of gravity as a result of batteries placed on top, and uncomfortable driving experience in the case of uphill stop-and-go traffic.

Key concerns that could not be concluded within the trial period included the following:

- Uncertainties about the battery warranty period and replacement costs
- Cost of electricity that would be imposed by regulators
- Uncertainty about long-term operation and maintenance costs

Likely need for larger batteries for longer routes in Egyptian public transport, implying concerns about its impact on passenger capacity, weight, and center-of-gravity.

Despite the satisfactory trial performance, the deal with NACC did not go through. The company showed greater interest in CNG technology, the other cleaner alternative, due to the growing overshadowing shift in Egypt toward CNG-fueled vehicles. Being significantly cheaper and justifiable in terms of investment and certainty about operation and maintenance in the future compared to

electric buses, CNG is also gaining traction on account of lesser local emissions, and the boost it will provide to local job production.

The trials did not include evaluation of scale-up requirements and grid impact and grid reinforcement needs. However, overheating of cables and melting in addition to poor electricity quality was noted during the charging, as a result of which the process had to be halted repeatedly for safety.

Lessons learnt

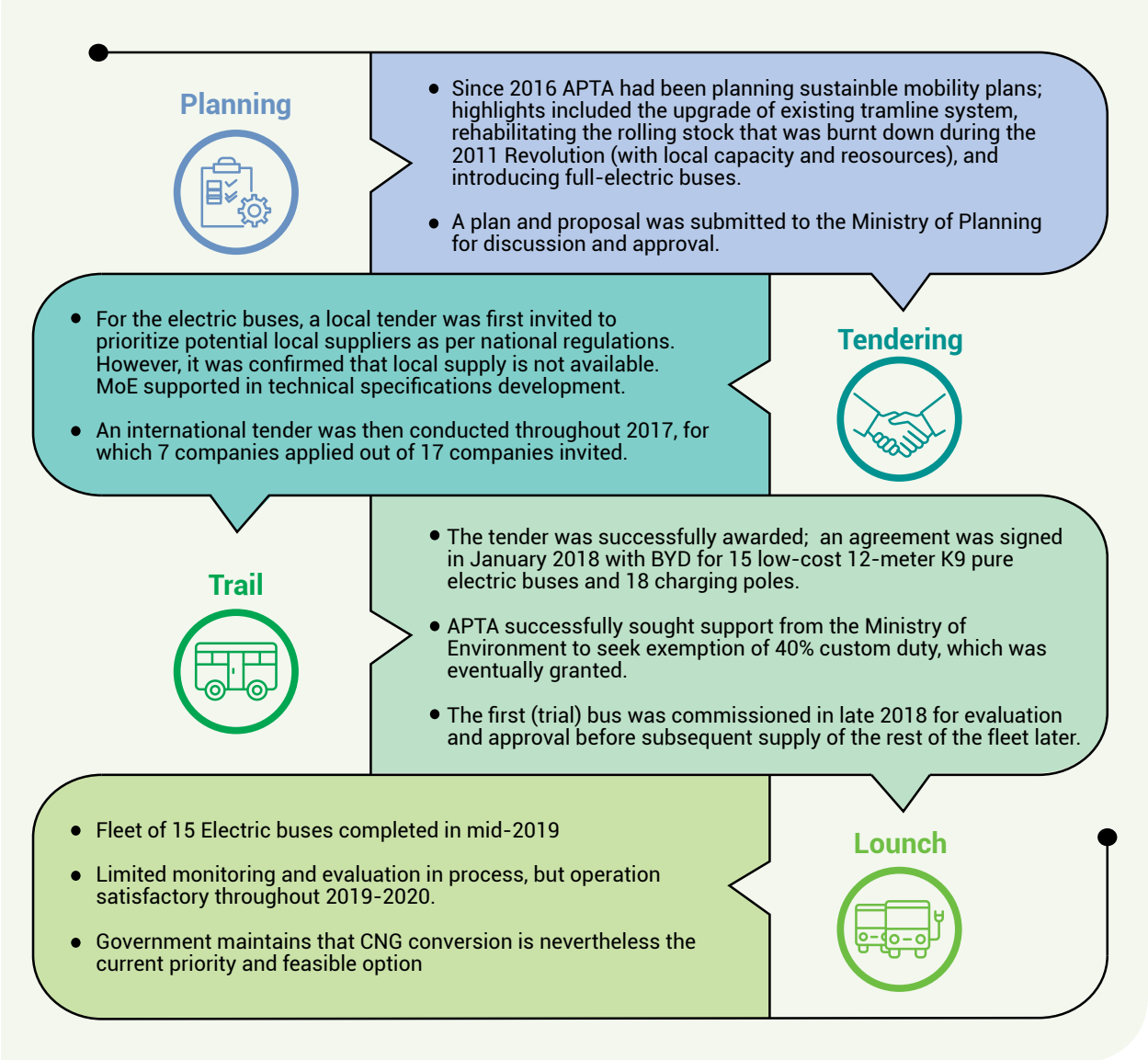
The key outcomes of this experience from the perspective of planning for investments are as follows:

- ***Range concerns:*** The 6-month trial was satisfactory although performance in peak summer conditions was not confirmed. But long routes in Egypt are a concern. For that reason, extra battery capacity and placement requirements would in turn impinge on safety, weight, passenger capacity, and price.
- ***Government support:*** Although the government is interested in electric buses, it is only providing supporting to the extent of removing barriers by way of custom duty exemptions, allowing trials by the private sector, and so on. It is yet to *subsidize* to compensate for price differences.
- ***Tenders:*** Tenders and contract templates issued by relevant authorities need to be revised to accommodate the specificities of electric vehicles and their charging needs, context-specific battery-sizing, and so on.
- ***Risk mitigation:*** Key concerns pertain to uncertainties about battery performance and replacement cost.
- ***Charging infrastructure:*** Trials have not included future requirements for charging infrastructure in case of scaling up. It is necessary that trials include such an evaluation in the form of grid impact and grid reinforcement needs.

3.8 Case study: APTA

The first significant demonstration of Electric Bus operation in Egypt is that of the Alexandria Passenger Transport Authority (APTA). In 2018, APTA signed an agreement to purchase 15 BYD electric busses that are today in operation in Alexandria. The timeline of developments however indicates the long process.

Figure 11: Process of Electric Buses introduction by Alexandria Passenger Transport Authority (APTA)



The process of evaluation of the first electric bus was conducted by the Military Technical College, mainly in a simple form to confirm range in full capacity and energy consumption behavior.

Among the identified needs of APTA to further advance electric bus systems is as follows:

- Preliminary feasibility study development, including TCO analysis.
- Capacity-building in monitoring and evaluation of vehicles, at both vehicle-level and system-level, and for the charging infrastructure and reporting.
- Orientation about access to climate finance as well as different financing models.

As already pointed out, custom duties of 40 percent are imposed on bus imports regardless of technology although electric cars are exempt. This implies a pressing need to do away the inconvenience of a lengthy and uncertain exemption request process.

The first significant demonstration of Electric Bus operation in Egypt is that of the Alexandria Passenger Transport Authority (APTA). In 2018, APTA signed an agreement to purchase 15 BYD electric busses that are today in operation in Alexandria.

3.9 Barriers to entry and uptake factors

In this section, key barriers to introducing scalable electric bus systems in Egypt are discussed. The evaluation of barriers is based on interviews with key stakeholders and experts and the working group of the Sustainable Urban Mobility for All (SuM4ALL).

- There is a lack of clear ownership on the part of public authorities, and a substantial delay in identifying the leading competent authority for specific new schemes. Often, the challenges are generalized under a generic heading, "e-mobility" for example. Not enough segmentation into sub-components and categories results in confusion, inefficient planning and communication, leading to tardy progress.
    - Solution: This can be avoided by timely development and dissemination of contextualized information as discussed in the next point. Additionally, capacity-building and experience-exchange events need to be intensified so that holistic plans can be developed to tackle specific multifaceted challenges, and plan accordingly.
- Despite being critical to the success of e-bus systems deployment, there is only a limited strategy focus on developing charging infrastructure and grid upgrade/reinforcement plans. This implies substantial uncertainty among transport authorities and private operators.
    - Solution: For electric bus systems, multiple scenarios for charging strategies must be developed and corresponding grid-impact studies conducted in line with plans in both the power sector and the transport sector. It should also respond to the national strategy ambition for EV manufacturing.
- Lack of timely 'Arabization' and contextualization of information content is needed to enable efficient stakeholder engagement for capacity-building. This includes normalizing the Arabic lexicon of emerging terminology for new concepts and ideas in order to effectively engage with all stakeholders including public authorities. This will cut out inefficiency in capacity-building due to lack of understanding.
    - Solution: The provision of educational content in Arabic and English, and also making it specific to the local context would go a long way in promoting efficient and constructive stakeholder engagement.
- Yet another bottleneck is the limited monitoring and evaluation of plans, policies, and programs, and an inclination toward trial-and-error approaches. This usually implies setting out with a tangible *outcome* like roll-out without adequately preparing for the enabling environment such as infrastructure, regulations, training, among others. The lack of monitoring, evaluation, documentation, and disclosure of transport sector interventions, including laws, regulations, pilot schemes, often leads to the repetition of mistakes, slowing down the learning process.
    - Solution: The monitoring and evaluation process in any future interventions is critical to its success. It is currently not the practice.
- Yet another hindrance to introducing e-bus systems at scale is the limited capacity of key public transport authorities of major cities, Alexandria and Cairo for example, in planning system-level solutions for public transport. They are also found lacking in adopting creative financing models and developing adequate support/subsidy schemes to devise appropriate tendering processes.
    - Solution: Targeted capacity-building of existing authorities and national and international

experience exchange between authorities and between cities is the need of the hour in Egypt. Experts suggest intensifying learning from international experience for which programs/ events, twinning programs, among others are advocated with reference countries. India and Chile are cited as good examples in this regard.

3.10 Summary of situation analysis

Electric mobility is advancing at a slow pace in Egypt, primarily characterized by the penetration of used electric *cars,* mostly since 2018. This was driven by the market demand and the corresponding exemption of custom duties, which slightly lowered purchase costs for early adopters, while the import of used electric cars was allowed up to May 2021, also facilitating ownership and stimulating the learning experience in Egypt.

The transport sector has seen rapid development since 2014 with unprecedented investments to expand and upgrade road networks and all forms of public transport systems, including metro lines, light and heavy rail, and bus systems. The stock of bus fleets dedicated to public transport is approximately 16,000, although only about half is in actual regular operation due to aging fleets.

A national EV strategy with roll-out targets is in place, championed by the Ministry of Military Production. What is referred to as the e-mobility strategy in Egypt is however actually a local manufacturing strategy. Industrial development is the main motive, primarily dedicated to state-owned companies, but the strategy lacks the necessary scope and depth in planning for the enabling environment. It also does not address the regulatory and policy barriers, or those relating to market and financing, capacity, knowledge, or technology. Therefore, the potential is humongous, and critical, in developing strategy at the national or city-level.

Even though the charging infrastructure does not pose a significant challenge yet due to the low penetration rate of electric vehicles that characterizes most developing countries, it must nevertheless be planned for in the long run. Due to limited charging needs of small-battery vehicles, which includes cars and micromobility vehicles, the gradual growth in demand can be met with incremental gradual development in the charging stations network – more than 130 charging stations today and growing. This is because almost all charging can be sufficiently met at home for most users.

Electric buses on the other hand, which is the focus of this study, imply substantial infrastructure requirements if a sizable fleet is introduced. To cite an example, 10 percent of the *operating* fleet in GCMA alone implies approximately 400 buses. The discussion of an e-bus future must therefore fundamentally be backed by studies on alternative charging strategy scenarios and the corresponding infrastructure and fleet requirements in local context.

Clearly, the capacity and knowledge barrier have prevented in-depth planning for large-scale e-bus adoption. The same challenge also afflicts manufacturing of EVs, for which a strategic plan is yet to be adequately incorporated for charging infrastructure, optimal charging strategies, grid reinforcements and upgrades. These are vital as the next steps of planning. This barrier led to an excessive dependence on learning-by-doing approaches rather than building a knowledge base of existing global experiences evidenced in case studies. It also emphasizes the need for intensified capacity-building and experience-exchange in early phases of the learning process.

However, several advantages in the current situation can be leveraged to favor electric bus systems. These are:

The transport sector has seen rapid development since 2014 with unprecedented investments to expand and upgrade road networks and all forms of public transport systems, including metro lines, light and heavy rail, and bus systems.

- An announced political will to advance electric mobility in Egypt, even if mostly focused on local manufacturing currently and less towards planning for deployment and developing the enabling environment and necessary incentives.
- Existing institutional thrust to implementing vehicle replacement schemes (Go Green Program and the like), enabling the transition to CNG alternatives, but also open to including EVs if found feasible and technically viable.
- The adoption of innovative/alternative financing models by the financial sector that that are more appropriate for e-mobility projects, and the availability of emerging green financing options that includes the recent initiation of the Green Bonds market.
- A continually declining grid emission factor (kgCO2/Kwh) that further increases the relative advantage of EVs in terms of carbon reduction. This is due to the improved efficiency of upgraded and new power plants and increases in renewable energy capacity, primarily from wind and solar energy. A temporary excess of power generation capacity is also available.
- Substantial learning experience already achieved through trials in Alexandria and Cairo, which supports the contextualization of the barriers expected in future scalable projects.
- The shift towards CNG buses implies higher upfront costs than the former choice of diesel buses. This accordingly reduces the gap between CNG, the current technology of choice on one hand, and electric buses on the other.
- Although natural gas is cheaper than diesel fuel, it will still be more efficient to use natural gas in the power sector rather than in ICE vehicles, implying further savings, while the resource is also spared for other high-return uses as well, such as chemical feedstock in other industries for fertilizer production or plastics.

The prospects for EVs are promising for other reasons. Development partners have committed substantial support in terms of strategy development. The e-mobility market is under study by the EBRD that is due in the near future. Another boost is coming by way of the World Bank-sponsored *Greater Cairo Air Pollution Management and Climate Change project*. This involves the introduction of a sizeable fleet of 100 electrical buses, which translates into developing the prerequisite strategy for charging infrastructure and the accompanying capacity-building on the part of local authorities.

In the meantime, demonstrational or flagship projects at a small scale are either under way – in Alexandria for example – or are planned in the near future. Two prominent examples of the latter category are, one, the announcement of the electric bus shuttle services between the airport and the flagship transport interchange hub of Adly Mansour, and, two, the flagship project in the Giza plateau showcasing the application of electric bus services for historical sites. For scalability however, reverting to the aforementioned strategy development and in-depth planning requirement remains fundamental.

Substantial learning experience already achieved through trials in Alexandria and Cairo, which supports the contextualization of the barriers expected in future scalable projects.

3.11 Examples of potential projects

Given the identified needs of the sector, the way forward for electric bus systems is still greatly constrained by limited capacity to plan for the charging strategies and required infrastructure. This section however provides examples of potential opportunities for investment for indicative purposes. However, a systematic strategic approach remains essential as discussed in the next section.
Ideal use cases for interventions aiming to integrate electric buses and bus systems in Egypt are ideally where the following criteria can be met:

- In cases where entities that want to expand bus fleets or substantially scrap and replace their vehicles
- In cases requiring scale up
- In cases where a clear owner is identified and backed with the necessary political will
- In *high-usage* purposes requiring high-mileage, high stop-and-go traffic, and other functions favoring life cycle cost parity

Accordingly, the following examples are identified and enlisted for indicative purposes:

1. **Cairo Transport Authority (CTA) and Alexandria Passenger Transport Authority (APTA):** Replacement scheme for existing fleets with set time-bound targets.
2. **Land Transport Regulatory Authority (LTRA):** Electric buses in prospective BRT project; announced inner ring road project under planning).

Investment in electric bus fleets is a promising and scalable prospect in Egypt if the necessary prerequisites are met. The enabling environment is still in an early phase of development, but the existing political interest and the commitment to local manufacturing of buses can be leveraged to accelerate the process.

3. **New Urban Communities Authority (NUCA):**
   3.1. Electric buses for new procurements by private operators in new urban communities and overlapping zones in the outskirts of GCMA.
   3.2. Electric buses specifically in foreseeable BRT projects under planning.

4. **GCMA Private Operators of Public Transport:** Gradual introduction of electric buses in new procurements or replacement of aging vehicles by private operators.

Once specific targets are set and corresponding charging strategies for roll-out are developed, a clearer understanding of grid infrastructure investments will be available, including the charging stations, safe grid connection requirements and substations where necessary. *Flagship* projects such as electric buses in the New Administrative Capital or in other low-usage routes or areas are prime opportunities, given the announced political will in support of e-bus deployment.

However, concerns linger about the perception of relatively lower advantage in comparison to conventional buses, and the choice of routes being less relevant to the actual areas facing air pollution. Central business districts are examples.

Furthermore, other flagship projects such as electric fleets for the Giza Plateau are unlikely to be scalable, and are also characterized by being low-usage vehicles. Therefore, they are less of a business case than buses used in regular public transport in dense urban areas. This is however despite the high value of such flagship projects, which nevertheless do provide the required promotion and proof-of-concept.

Financing models and other financial support

A necessary prerequisite to the roll-out of electric buses will be the provision of adequate financing models that must be designed on a case-by-case basis. A promising approach followed in Egypt is the use of financial leasing options as per the Financial Leasing and Factoring Law No.126/2018, to offset the burden of high upfront costs. In fact, It is necessary to leverage the existing green financing options and climate finance to partially cover cost differences in fleets, or in investment in infrastructure.

3.12 Recommendations for Government and Development Partners

Investment in electric bus fleets is a promising and scalable prospect in Egypt if the necessary prerequisites are met. The enabling environment is still in an early phase of development, but the existing political interest and the commitment to local manufacturing of buses can be leveraged to accelerate the process. In the meantime, numerous parallel activities of relevance by public authorities and development partners are in process. Among relevant studies that have been undertaken to assess the market, is most prominently the EBRD *E-mobility strategy and market study* yet to be disclosed. In addition, the World Bank is planning studies for their upcoming activities as part of the demonstrational project component for e-mobility. This, along with initiatives by various public authorities, should ideally be coordinated through adequate stakeholders experience-exchange activities dedicated specifically to bus systems. The objective should be to encourage alignment with a national e-bus strategy.

A good reference example is Jordan, presented in the following chapter. The country's Ministry of Energy and Mineral Resources (MEMR) has taken the lead in bringing together key relevant stakeholders, including development partners, to ensure coordination towards boosting e-mobility.

Policy & Legislative needs

In order to pursue carbon reduction targets in the transport sector in tandem with the ambition for local manufacturing of green technologies, the following policy recommendations have been concluded through stakeholder consultations, review of international best practices, and expert evaluation:

- **Setting targets:** The need for setting specific targets for penetration of electric buses cannot be overemphasized. This would help to develop a corresponding national, or city-level, strategy for charging and corresponding infrastructure reinforcement.

- **Discourse adjustment:** The criteria for assigning certain technologies the label of *Green Technologies* also needs to be revised so as to consider carbon emissions. This refers specifically to the use of natural gas in vehicles, considering that it is a fossil fuel with life-cycle carbon emissions comparable to the diesel fuel it replaces. This would also help align with the international trend of shifting toward electric mobility, and also tap into climate finance and related support when shifting towards green technologies.

- **Policy consistency and fair comparisons:** To ensure policy consistency, the detrimental impact of high-Sulphur diesel – current levels exceed 2,600 ppm – should be mitigated by imposing safe fuel quality standards, and prescribing emission standards for diesel fuel vehicles. This, in turn, would imply higher purchase costs of the 'up-to-specs' diesel fuel vehicles, bridging the gap with the high upfront costs of EVs.

    - ***Emission regulations and standards for vehicles:*** Specific emphasis on the need for improved emission standards and monitoring capability for vehicles is necessary because of the severe air pollution. This is also relevant to e-mobility as it limits the unfair technology competition from low-quality ICE vehicles that create a larger gap in ownership costs.

    - ***Polluter-Pays-Principle such as LEZs or bonus-malus/feebate schemes and UVARs:*** Introducing measures to ensure polluting vehicles pay is necessary to nudge the market towards EVs. Common measures of feebate systems or Low-Emission Zone scheme are appropriate forms of aligning with Polluter-Pays Principle along with other favorable Urban Vehicle Access Regulations (UVARs). The objective in each of the above is to moderate traffic loads while incentivizing cleaner and *smaller* vehicle alternatives and vehicle-sharing concepts, in acdition to also conserving public space.

- **Assign clear roles and responsibilities:** Egypt is yet to assign roles and responsibilities for advancing different components of the e-mobility. In order to facilitate cooperation with development partners, it is fundamental to keep distinct the mandate of *manufacturing* and *market uptake*; the stakeholders (or committees) for manufacturing of EVs are not the same as stakeholders for planning market uptake. Such misunderstanding may cause substantial confusion and delay in planning.

- **Focus on service requirements and standards rather than technologies:** Among the challenges faced by operators are the specifications imposed on fleet purchases necessary for new concessions. The specifications may be relevant to ICE vehicles, specifically in the case of *range* requirements. As a result, electric buses that are operated with smaller batteries with plans for opportunity charging, and therefore low range, are forced to opt for more expensive large-battery alternatives. That is not all. Other technology standards such as those pertaining to carbon emission and higher diesel specifications would also impel greater adoption and scale-up of electric buses.

- **Set monitoring and evaluation programs for fleet renewal schemes:** A monitoring and evaluation study of the performance of the current CNG conversion scheme is recommended for an in-depth comparison with electric bus schemes and to build a business case for the government and clarify misconceptions if any, and ensure better management of natural gas resources. This could be in terms of penetration rate, infrastructure investments into stations and performance, vehicle performance and operational costs, energy consumption and well-to-wheel carbon emissions, among others.

Electric buses that are operated with smaller batteries with plans for opportunity charging, and therefore low range, are forced to opt for more expensive large-battery alternatives. That is not all. Other technology standards such as those pertaining to carbon emission and higher diesel specifications would also impel greater adoption and scale-up of electric buses.

In Egypt, any valid comparison on the Total cost of ownership (TCO) of EVs has to be based on comparison with CNG buses in accordance with the national agenda to switch to CNG. That is because only a comparison with CNG correctly factors in the cost of E-buses.

Capacity and Knowledge needs

The following recommendations are concluded to address the capacity and knowledge gaps associated with electrification of bus fleets:

- **Infrastructure studies:** A study for city-level charging strategies and grid reinforcement needs, is necessary considering the following basic scenarios and the corresponding fleet specifications:

  - Depot (overnight) charging.
  - Combinations of depot charging and opportunity (fast) charging.

  This would not necessarily cater to one operator but can be a masterplan to cater to the entire set of fleets in each city. Other variations or charging technologies may also be investigated, on-route charging for example.

- **Capacity development for system-level (hyperlocal) solutions and TCO analysis:** Training is necessary for detailed Total Cost of Ownership analysis and system optimization, including charging strategies, battery rightsizing, data analytics, battery specifications, context-specific requirements for hot climates. Expertise also needs ro be developed for electric mobility fleet management, enabling tools and guidelines, and comparisons with CNG technologies.

- **Experience-exchange with other cities of similar/ comparable context**: Sharing of international best practices, particularly in dense cities in developing countries, is recommended. This could be by way of seminars and exchange visits, or possibly city twinning programs.

- **Financing models orientation:** Training on alternative financing models for EV fleets and charging business models is crucial, as is training on access to climate finance.

Market and Financial needs

Key needs associated with market and financial barriers are as follows:

- **It is paramount to ensure alignment between national authorities and development partners toward a common understanding of the baseline parameters of ICE and related infrastructure** with which e-mobility solutions are compared. This is required to secure the policies needed to protect the business case and environmental impact case of EVs. Broadly speaking, it could be done by enforcing adequate standards for ICE vehicles, ruling out cheaper ICE alternatives, or permitting only certain standards in specific *zones*.

  In Egypt, any valid comparison on the Total cost of ownership (TCO) of EVs has to be based on comparison with CNG buses in accordance with the national agenda to switch to CNG. That is because only a comparison with CNG correctly factors in the cost of E-buses. To cite an example, of a 12 meter MCV electric bus is be indicated to be only 14 percent more expensive than its comparable CNG-fueled counterpart, but approximately 68 percent more expensive than a comparable diesel-fueled counterpart, which is being gradually phased out in Egypt.

  Operational costs if EVs would come down further by reducing battery sizes. Therefore, system-level planning and infrastructure investments must be included to capture accurate comparisons, with the consideration that the government can play an active role in providing infrastructure as an incentive for e-mobility players. There is more. *Data analytics,* retrieved from vehicles in use, can help reveal opportunities for further cost reduction by rightsizing of batteries and optimization with the charging infrastructure.

- **There is an acute need to develop EV-relevant tendering and procurement procedures.** Extrapolating the existing tendering procedures for conventional ICE vehicles without sufficient tailoring them to the requirements of electric buses is of no value. Providing for context-specific range requirements, battery specifications and warranty requirements, different charging strategies, is an area of necessary support.

- **Incentivizing the operational costs of EVs or charging costs will go a long way to promote their adoption.** For this, incentives must be put in place in the form of favorable charging tariff scheme as compared to the competing low-cost CNG fuel.

Technical needs

Key needs associated with technical barriers are as follows:

- **Grid reinforcement and capacity improvement:** After prerequisite national and city-level grid impact assessment studies, grid reinforcement would need to be undertaken in the central business districts of large cities. The assessment studies would help in planning for enhancement of capacity of cable lines and transformers, local storage, power factor compensation through capacitor banks, and adequate EV charger specifications to avoid harmonic distortions and voltage impacts. Concerns over quality of power supply and existing infrastructure were already evident during pilot tests of charging electric buses in Cairo.

- **Charging stations/depot:** A key concern in planning the charging infrastructure is the peak demand for prospective overnight charging. At a charging rate similar to the trials of existing e-bus trials in Egypt, a penetration of 1,000 electric buses can imply a power demand reaching 50MW or more throughout the night. This would invariably translate into harmonics distortion and overloads on distribution cables and transformer, among other concerns. All these technical challenges can be easily addressed through known practices. Other solutions to mitigate peak demand issues include system-level solutions of charging strategies that may include certain combination of overnight charging and opportunity charging.

- **Space for depots:** In the case of dense cities afflicted with air pollution, the space crunch poses substantial challenge to setting up charging depots at appropriate locations; those far from the zone of operation would lead to substantial increase in 'dead miles', or operational expenditure. Therefore, context-specific solutions are needed to tackle this technical challenge.

- **Battery life cycle management:** There are no announced plans or discussions about battery life cycle management yet, and it is an important area for support in the future. This could be in the form of plans for reuse, safe recycling, material recovery, effect of hot climate, and so on. This may also have significant implications on the business case of electrifying bus fleets.

Two parallel areas for intervention are recommended as next steps: (a) Capacity building and experience-exchange – national and international) – to align the understanding of all key stakeholders, and (b) detailed context-specific TCO analysis in scenarios involving emission regulations and different charging scenarios. The geographic scope (e.g. specific city) or alternatively a project-specific scope (e.g. BRT) can be identified in coordination with the Ministry of Environment, and comparison must primarily be with CNG technologies.

A further prerequisite to the enabling environment is also greater access to public transport data and grid infrastructure data so as to facilitate development of system-level solutions.

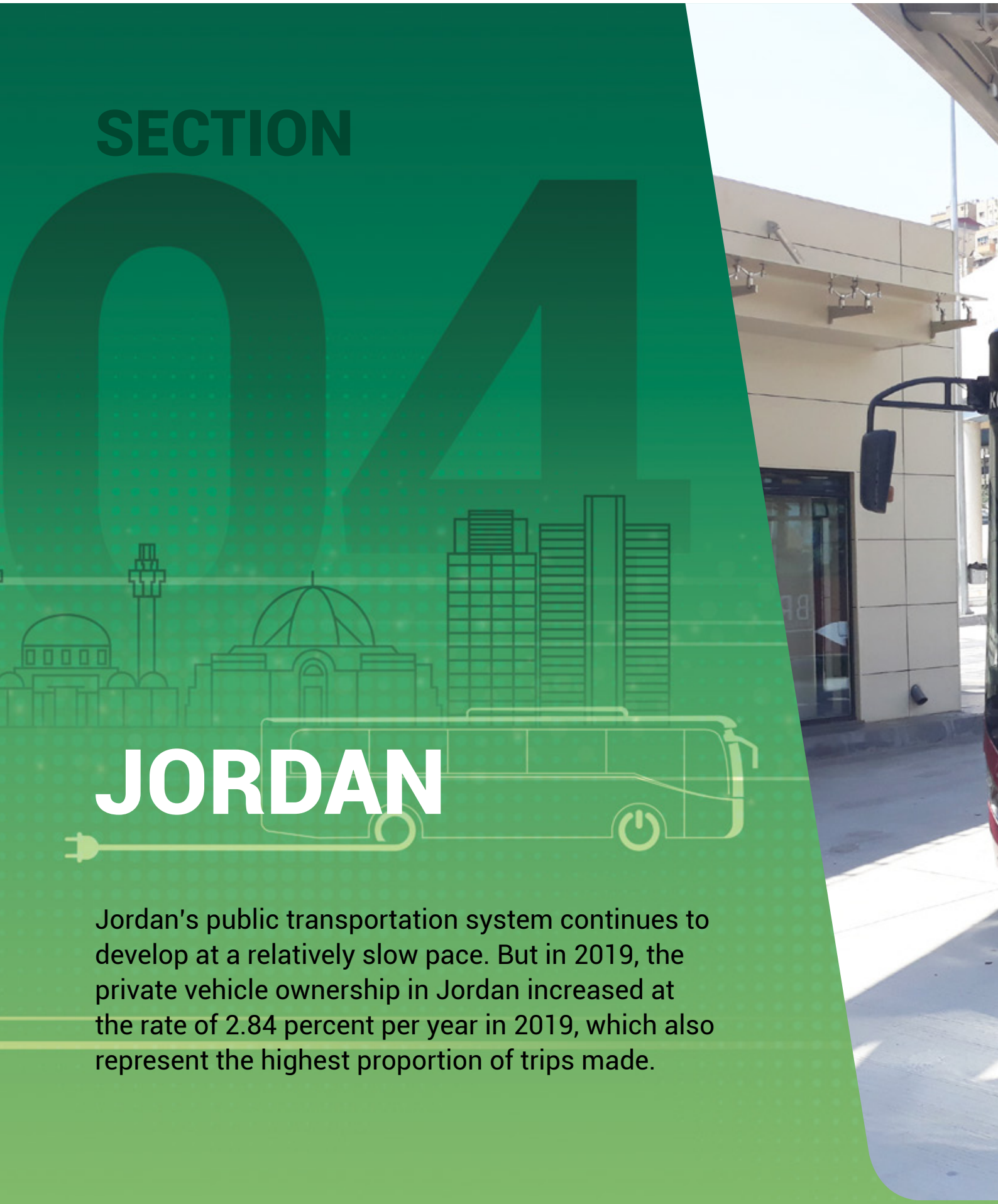
However, considering the national strategy for electric vehicles, it must be noted that an accompanying process of grid reinforcement is implicit in the ramp-up of electric vehicles – foreseen to reach 2 million EVs by 2040. This is understood to be partly met through local production of passenger cars, highway buses, and city buses. However, a separate planning process specifically for electrification of bus fleets and corresponding scale-up is not evident to date.

The most significant foreseeable development in this respect is the project led by the World Bank, The Greater Cairo Air Pollution Management and Climate Change Project, which includes a component for introducing 100 electric buses along with the necessary planning prerequisites. Other initiatives are not part of a systematic approach and limited to smaller scales and scopes of demonstration.

> A key concern in planning the charging infrastructure is the peak demand for prospective overnight charging. At a charging rate similar to the trials of existing e-bus trials in Egypt, a penetration of 1,000 electric buses can imply a power demand reaching 50MW or more throughout the night.

SECTION

04



JORDAN

Jordan's public transportation system continues to develop at a relatively slow pace. But in 2019, the private vehicle ownership in Jordan increased at the rate of 2.84 percent per year in 2019, which also represent the highest proportion of trips made.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4.1 Overview of transportation sector

Jordan's population witnessed rapid growth in past decades due to an influx of refugees fleeing conflict in neighboring countries. According to the Department of Statistics (DoS), Jordan's population reached 10.7 million in 2020. In 2019, the Gross Domestic Product (GDP) per capita was JOD 2,994 (USD 4,222), with a growth rate (constant prices) of 2 percent. However, due to economic slowdown as a result of COVID-19, GDP witnessed a decline by 1.6 percent in the 4th quarter of 2020.[47] The rapid population growth places considerable pressure on the country's transport infrastructure, including both the transport network and services. In particular, Jordan's public transportation system continues to develop at a relatively slow pace. But in 2019, the private vehicle ownership in Jordan increased at the rate of 2.84 percent per year in 2019, which also represent the highest proportion of trips made.[48]

General overview of the sector

In the capital Amman, about 59 percent of its area is currently unserved by formal public transit, and approximately 37 percent of its population has limited access to public transport services [49]. The absence of a reliable public transportation system results in less transit-oriented communities, as people continue to seek private vehicles as means of transport.There is little data on other modes of transport in Jordan but cycling and walking represents a very low proportion of the transportation mix across the country's different localities.[50]

The following table provides the percentage of the area served by public transport in the capital Amman, indicating opportunity for further improvement in accessibility[51].

Table 5: Area served by public transport in Greater Amman

Indicator	%
Area served by public transport within 300m	% 48
Area served by public transport within 500m	% 64
Area served by Amman BRT within 300m	% 3.5
Area served by Amman BRT within 500m	% 6.1

Source: GAM, 2018

According to Jordan's Third National Communication (TNC) to the United Nations Framework Convention on Climate Change (UNFCCC) issued by the Ministry of Environment (MoEnv), the transportation sector in Jordan is the second-largest contributor to Greenhouse Gas (GHG) emissions. The sector contributes approximately 16 percent of total emissions,[52] and accounts for 52 percent of the total energy bill in 2019.[53]

The transportation sector plays a critical role in Jordan's economic growth and enabling environment for investment. Transport accounts for 9 percent of Jordan's GDP[54] and employs an estimated 7.6 percent of the labor force.[55] According to the Transport Sector Green Growth National Action Plan (GG-NAP) (2021-2025), improving access to reliable transportation services is a national priority in order to achieve socio-economic prosperity. A sustainable transportation system is seen as a prerequisite to social inclusion and equal access to opportunities, particularly among women and under-represented groups.[56]

Jordan's road network covers more than 9,000 km, connecting different governorates nationally as well as Jordan to its neighboring countries.[57] Recent and ongoing key highway and road development projects include[58]:

The transportation sector plays a critical role in Jordan's economic growth and enabling environment for investment. Transport accounts for 9 percent of Jordan's GDP54 and employs an estimated 7.6 percent of the labor force.55 According to the Transport Sector Green Growth National Action Plan (GG-NAP) (-2021 2025), improving access to reliable transportation services is a national priority in order to achieve socio-economic prosperity.

- Rehabilitation and improvement of the Desert Road project
- Implementation of Irbid Ring Road (Part 1) project
- Maintenance of Irbid / Amman Road project
- Implementation of the Bus Rapid Transit (BRT) between Amman and Zarqa project
- Implementation of the BRT in Amman governorate
- Salt Ring Road Project (Part Two)

Aqaba is Jordan's only seaport and is run by the Aqaba Container Terminal (ACT), which exports 78 percent of Jordan's production and imports 65 percent of its cargo. The Aqaba Special Economic Zone Authority (ASEZA) is responsible for economic development and infrastructure management within its jurisdiction in Aqaba, with its commissioner reporting directly to the Prime Minister.

Air transport plays a strategic role in Jordan's economy. The Civil Aviation Regulatory Commission leads the development of the regulatory framework. Its three airports, Queen Alia International Airport (QAIA), Amman Civil Airport, and King Hussein International Airport[59], perform the formidable task of coordinating the provision of air navigation services, legal affairs, regulation as well as safety and security in Jordan. QAIA represents one of Jordan's first successful public-private partnerships (PPP).

Policy context and direction

The policy and investment framework for the transport sector in Jordan has been developing at a relatively slow pace compared to other sectors like energy. However, advancing Jordan's transportation sector is a national priority, with a focus on enhancing service quality, transport infrastructure, and policy development (further details provided in section 4.2)

The National Long-Term Transport Strategy-Phase Two for the years (2018-2020) includes plans to regularly reform laws and regulations, develop the information technology infrastructure, and allocate the financial resources required to develop the sector. Additionally, the government has increasingly focused on the strategic role of PPPs in key infrastructure sectors, and has been strengthening the legal environment to promote private sector participation in national public investments.[60] This is evidenced by the issuance of the PPP Law No. 17/2020 and the creation of a PPP Unit at the level of the Prime Minister's office.

The transport strategy aims at developing national transportation projects, with considerable attention to the associated environmental impact. This includes strategic public transport and logistics projects, such as the expansion of QAIA, establishing a heavy rail system, BRT systems, and other major road expansion projects. These projects are seen as critical for achieving Jordan's vision in building sustainable and resilient transport infrastructure and enabling its role to act as a major hub for interconnection in the region.[61]

Vehicles in Jordan

The inadequacy of a safe, reliable and accessible public transport system has resulted in rising rates of private car ownership in Jordan, implying a challenge to modal shift towards buses. Operating a large number of private vehicles puts pressure on the transportation network, exacerbating air and noise pollution. In 2019, there were 1.68 million vehicles of different types registered in Jordan, 1.18 million of which are privately owned cars. Average annual increase in vehicle registration ranges from 5.4 percent in 2017, 3.3 percent in 2018, to 2.8 percent in 2019.[62] The following table provides further statistics on vehicles in Jordan.

Table 6: Key statistics on licensed vehicles in Jordan according to prevailing categorization

Type	Private vehicles	Public Vehicles	Total
Medium-size sedan (Saloon)	1,184,878	24,735	1,209,613
Buses	17,777	8,749	26,526
Other	356,524	87,584	444,108
Total	**1,559,179**	**121,068**	**1,680,247**

Source: DoS, 2019.

- Public transport fleets in Jordan are divided into three main categories: public, tourism, and rental transport services. According to the Land Transport Regulatory Commission (LTRC), the average operational age of the public transport fleet is 10.6 years.[63] LTRC does not issue any specification on environmental requirements for operating public busses. The dominant type of buses in Jordan is diesel buses, but there are no specifications regarding fuel type – Euro IV, Euro V, and so on. Rather, the main specification issued by LTRC for operating buses refers to engine capability to operate at a power of 14 horsepower for every ton of weight[64]. However, the Environment Protection Law (No.6/2017) requires vehicles to comply with specific emission limits. According to the instructions on vehicle preparation issued under the Traffic Law (No.49/2008) in 2020,[65] gases emitted from vehicles with gasoline engines should be as follows:

- CO: 5 percent or less.
- Hydrocarbon (HC): 600 (per million) or less
- O2: 6 percent or less
- CO2: 10 percent or less

While for vehicles with diesel engines, the maximum allowed density of smokes emitted from the exhaust is 70 %. Additionally, it is required that diesel engines are integrated with a device to filter diesel fuel.

Furthermore, the Jordan Standards and Metrology Organization (JSMO)[66] provides various standards regarding gas emissions related to engines, as follows:

- Motor vehicles - Emissions (Diesel engines) (JS 1053:1998): measures should be followed to assess pollution levels and gases from diesel engines and vehicles with diesel engines
- Motor vehicles - Emissions - Diesel engines (JS 1054:1998): provides the standards for gaseous pollutants from vehicles with diesel engines.
- Motor vehicles – Emissions (JS 1052:1998): provides gaseous pollutants standards, which applies to all vehicles equipped with a combustion engine from types N1 and M1.

LTRC holds regulatory authority over the public transport sector in Jordan, except for Greater Amman Municipality (GAM) and ASEZA jurisdictions, and statistics are therefore disaggregated accordingly[67]. The following table provides the latest statistics on the breakdown of public fleets by type and jurisdiction.

Table 7: Statistics on public transport buses in Jordan according to prevailing categorization

Type of fleet	Number of vehicles
National Statistics*	
Public transport buses (9-30 seater) *(excluding GAM and ASEZA)*	3,477
Public transport buses (above 30 seats) *(excluding GAM and ASEZA)*	776
GAM**	
Public transport buses (9–30-seater)	340
Public transport buses (above 30 seats)	524
ASEZA**	
Public transport buses (9-30 seater)	41
Public transport buses (above 30 seats)	11

*Source: LTRC, 2020.
**Source: Al- Balqa Journal for Research and Studies, 2018

Fuel and Electricity

In Jordan, the Energy and Minerals Regulatory Commission (EMRC) sets the regulations and standards for electric vehicles, including setting the purchase and retail price of electricity. This was structured to primarily enable penetration of electric cars during a USAID project throughout 2015-2016. However, the regulatory framework for buses is uncertain at the current stage of learning.

The charging infrastructure for EVs revolves around public charging infrastructure for electric cars Among the several ad hoc initiatives providing limited infrastructure, but none associated with buses, are fast chargers installed by private company Manaseer Group and the wall connectors and superchargers at high-end destinations and selected routes by automaker Tesla. Rates of home-charging are accordingly high.

With recent formation of an inter-ministerial committee led by the Ministry of Energy and Mineral Resources (MEMR) dedicated to e-mobility promotion, there are renewed prospects dedicated to the needs of electric

buses specifically. The necessary support from the community of development partners is noted. However, prerequisite studies such as grid-impact assessments and analysis of reinforcement needs are yet to be developed in this regard.

The following table provides an overview of fuel prices and average public transport fare price. For the sake of comparison, diesel fuel is slightly lower priced in Jordan than in Morocco, but almost double in price compared to that in Egypt. The electricity tariff is proportionately about double that of Egypt.

Table 8: Overview of fuel/electricity prices for vehicles in Jordon

Type	Price JOD (USD)
Diesel	0.580 JOD/liter (0.82 USD)*
Electricity (for EV charging)	0.147 JOD/kWh (0.21 USD)**

Source: MEMR, 2021*, EMRC, 2021**

Clean energy

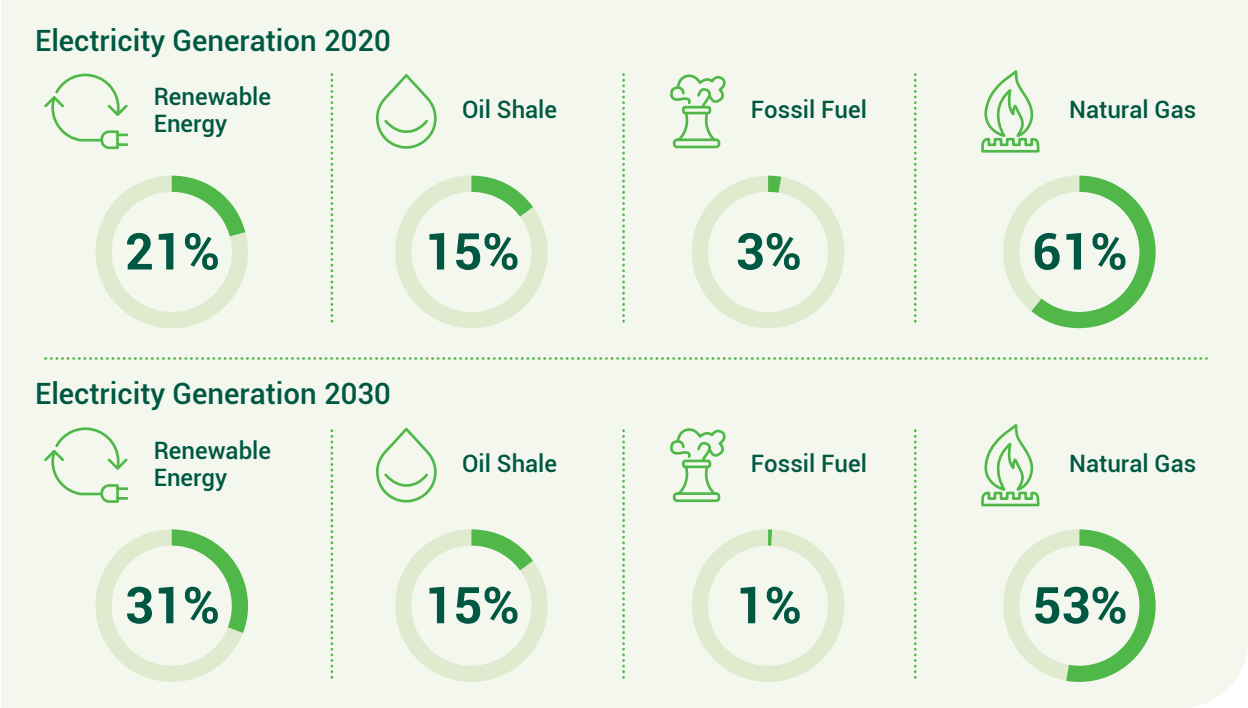
As one of the first countries in the region to establish renewable energy (RE) regulatory framework and market, Jordan has already introduced utility-scale RE projects to decarbonize the energy sector and reduce reliance on external resources for its energy needs. Accordingly, the share of RE in the total electricity production was 10.8 percent in 2018.[68] Developing an adequate legal framework was instrumental in the successful deployment of RE in the country, particularly due to the issuance of the Renewable Energy and Energy Efficiency Law (REEEL) (No.13/2012). This played a key role in the deployment of RE systems and energy efficiency (EE) across the country, attracting investments both at large utility-scale and smaller scale for distributed systems.

Recently, the Ministry of Energy and Mineral Resources (MEMR) released the Jordan Energy Strategy (JES) for the years 2020-2030.[69] JES investigated four different energy scenarios for Jordan and adopted the "Increase Self-reliance" scenario. This aims to increase the share of RE in the total energy mix to 11 percent by 2020 and 14 percent by 2030. The strategy subsequently aims to increase the share of RE in electricity production to 21 percent by 2020 and 31 percent by 2030. JES also has a strategic objective of encouraging and adopting e-mobility in Jordan, which underscores the leadership position MEMR is playing in this area.

4.2 E-mobility in Jordan

The Government of Jordan (GoJ) has played a proactive role in increasing the deployment of Electric Vehicles (EVs) in Jordan, but with a focus on private cars rather than buses. This has been enabled by the MoEnv's initiative to introduce tax and customs exemptions for e-cars since 2015, although these policies have fluctuated since 2019. As a result, the number of e-cars exceeds 24,000 in 2021[70], mainly owned by private individuals apart from a few governmental initiatives as discussed in this section. Programs for electrification of taxi fleets are also in gradual development.

Figure 12: Sources of electricity in the Jordan Energy Strategy 2020-2030 (Source: MEMR, 2020)



The Government of Jordan seeks to decarbonize the transport sector in order to cut down emissions, reduce spending on fuel, and enhance energy security for the country. To this end, there have been public initiatives to electrify public transport within the Petra Development and Tourism Region Authority (PDTRA) and GAM,

The Greater Amman Municipality (GAM) initiated a first of its kind all-electric "Tawseeleh" taxi fleet, mobilizing 30 zero-emission Nissan Leaf e-cars.[71] The project has been implemented in cooperation with Taxi Al Moumayaz, a leading taxi company that has adopted hybrid and electric vehicles (HEV) for their fleet. Al Moumayaz is estimated to have deployed around 100 e-cars (mainly used Nissan Leaf e-cars) in their fleet, which is a promising development.

The Government of Jordan seeks to decarbonize the transport sector in order to cut down emissions, reduce spending on fuel, and enhance energy security for the country. To this end, there have been public initiatives to electrify public transport within the Petra Development and Tourism Region Authority (PDTRA) and GAM, discussed in further detail in sections 4.7 and 4.9 respectively). On the commercial side, Aramex, a courier and package delivery company operating in Jordan and the region, has piloted e-vans within its fleet operating in Amman.

In Jordan, there is limited data on the number of electric micro-vehicles; there are also no shared micro-mobility initiatives that operate in the country. However, e-bikes ('electric-assist' or 'peddle assist' bicycles) are increasingly observed on the roads, particularly in Amman for private use and for other usages such as delivery services. These may eventually to last-mile solutions for bus systems.[72]

Key E-mobility initiatives

Although EVs in Jordan are predominantly owned by private individuals with over 20,000 e-cars on the roads, there have been initiatives by the public and private sectors to promote EVs, including the following key initiatives:

- PDTRA: Piloting 2 e-buses
- GAM: Plan to deploy 15 e-buses within Amman bus fleet
- Aramex: Operating 10 pilot electric vans
- Royal Hashemite Court: Operating 150 Renault Zoë's and a number of Tesla Model S's
- GAM: Released 30 Nissan Leaf e-taxis
- GAM: Deployed about 150 EVs, mainly Renault Zoe e-cars, constituting a third of the fleet

National and subnational strategies

This section provides an overview of the national and sub-national strategies by the Government of Jordan that address public transport, decarbonizing the transport sector and deploying e-mobility in the country.

Jordan Vision 2025: Jordan's Vision 2025 underscores the importance of the transportation sector as a key driver for development. The objectives of Vision 2025 for the sector include:[73]

1) Achieve sustainable growth that ensures overall adequate standards of living.

2) Create an investment environment capable of attracting foreign capital and encouraging foreign investments.

3) Justly distribute and improve the level of service among citizens.

GoJ Priorities of Action (2020-2021): Low accessibility, unreliability of trips and the lack of safety measures are among the challenges the transport sector encounters. The Government Priorities of Action (2020-2021)[74] also targets:

- Increasing the share of public transport users (mode share)
- Increasing the operating buses by 11 percent for every 1,000 citizen by 2020
- Renewing 25 percent of the public bus fleet by 2020
- Installing Intelligent Transport System (ITS) for public buses in Irbid, Jerash, and Amman.

JEGP 2018-2022 and the 5-Year Reform Matrix (5YRM): The Jordan Economic Growth Plan (JEGP) for the years 2018-2022[75] includes strategic reform areas to develop high quality, safe and sustainable transport services as one of its key pillars. JEGP targets a 5 percent growth in total GDP by the transport sector. The total targeted growth is pegged at USD 1.8 billion through 2018-2022; therefore the needed growth from the transport sector is estimated to be around USD 334 million. Additionally, the plan underscores the significant socio-economic benefits accruing from a developed and sustainable transportation system. This is in addition to significant benefits such as preserving natural resources and protecting the environment. The plan strives to enable an investment atmosphere that attracts both Arab and foreign investments to ensure an uncomplicated, competitive business environment. The main transport-related interventions proposed by JEGP are:

- Provide a safe, effective, and integrated public transport system by developing a reliable public transport system, mainly in Amman, Irbid, Zarqa and Madaba. Additionally, it aims to develop and operate an Integrated Ticketing & Scheduling (ITS), along with establishing a reliable data warehouse.
- Complete and upgrade transportation network infrastructure, to be achieved mainly through developing and enhancing Jordan's three international airports.
- Enhance the efficiency of the land cargo transportation by upgrading the Jordanian road transport fleet through the provision of service facilities, in addition to capacity-building for professional drivers and managerial staff.
- Enhance multi-modal transportation by establishing a national cargo-based railway network and dry ports in Amman and Ma'an.

In addition, the 5YRM focusses on enhancing the quality standards in the sector, operationalizing a code of conduct, introduction of mobile application to report sexual harassment, and targeted road safety measures.

Government Indicative Executive Program (GIEP) 2021-2024: The program builds on previous economic reforms and takes into consideration the current economic challenges as a result of the COVID-19 pandemic. The program's main pillars include: "structural and economic reforms, political development, digital and green economy transformation, investments and productive sectors, developing infrastructure, improving social services, reducing employment and poverty and increasing self-reliance".[76]

Nationally Determined Contributions (NDCs): Jordan first introduced EVs through the Nationally Determined Contributions (NDCs)[77] in 2015 as a signatory to the Paris Agreement and in line with the Climate Policy. The NDCs propose the deployment of 3,000-strong charging station network powered by RE to promote the adoption of EVs in Jordan. It also highlights the need for coordination between GoJ and the private sector to develop proper policy and legislative framework. This is projected to contribute to Jordan's NDCs that aim to reduce GHG emissions by 14 percent by 2030 –with 1.5 percent to be unconditionally met by the country's own means, and 12.5 percent dependent on external financial support. As the transportation sector in Jordan is the second-largest contributor to total GHG emissions,[78] decarbonizing the sector is critical in supporting the country's commitment towards the Paris Agreenment and the Sustainable Development Goals (SDGs.)

Transport Strategy: Although the Ministry of Transport (MoT)'s latest strategy (2018-2020) does not clearly refer to e-mobility or EVs in any of its proposed projects in the action plan, it does include the following strategic goals[79]:

1. Develop the transport system through upgrading networks and transport infrastructure. This is in addition to providing reliable, safe and reasonably-priced public transport systems that would ensure social development and inclusion.
2. Foster public-private partnership by enabling the private sector in developing the transport system. To stimulate investment, appropriate policies would need to be in place.
3. Ease the trade and transport system, leveraging Jordan as a strategic geographical location to foster regional trade.
4. Contribute to providing for environment-friendly transport systems that would contribute to sustainable development. In particular, implement the Amman-Zarqa BRT project.
5. Enhance institutional performance through capacity-building and establishing a data center for the transport sector.

Provide a safe, effective, and integrated public transport system by developing a reliable public transport system, mainly in Amman, Irbid, Zarqa and Madaba. Additionally, it aims to develop and operate an Integrated Ticketing & Scheduling (ITS), along with establishing a reliable data warehouse.

impacts, mainly through upgrading public transport fleets, prioritizing investment in the sector, pursuing a multi-modal transport system approach and introducing different mobility options to help reduce dependence on private vehicles.[80] An update to the transport strategy is under way, which includes a stronger focus on linking with environmental and climate priorities.

National Green Growth Plan (NGGP)/ Transport Green Growth National Action Plan (GG-NAP): Building on the National Green Growth Plan (NGGP) issued in 2017, the MoEnv recently released the Transport Sector GG-NAP[81] for the years 2021-2025 with the following green growth objectives:

1. Enhance natural capital
2. Promote sustainable economic growth
3. Foster social development and poverty reduction
4. Incentivize Resource efficiency
5. Push for climate change adaptation and mitigation

In order to achieve green growth in the transport sector, the MoEnv, MoT, the Global Green Growth Institute (GGGI), and other stakeholders, worked together to identify 13 priority actions in the sector. These include:

- Investment preparation and demonstration actions: These comprise a variety of projects at different levels of readiness for public-private partnerships, direct private investment, or climate finance opportunities. Among a slew of seven planned actions are establishing a low-carbon municipal fleet for Zarqa, Madaba, and Irbid; designing and implementing a public electric mobility pilot project in Amman; supporting the deployment of ITS for the transport sector; and scaling up the provision of public-school bus services in all municipalities.
- Enabling policy and institutional reform actions: These aim at attracting investment by addressing policy gaps and barriers to minimize risks, in addition to uncertainty and instability in policymaking. Among six such mandates are developing a *national electric mobility strategy* and an *action plan*; and developing transport and capital investment action plans for Mafraq, Irbid, and Zarqa.

Energy GG-NAP. The Energy Sector Green Growth National Action Plan (GG-NAP) for the years 2021-2025, identifies 12 priority actions, which include four investment preparation projects, demonstration actions, and eight enabling policy and institutional reform actions[82]. The actions that are relevant to e-mobility and would support its deployment in the country are broadly fall into two categories:

- **The first set pertains to implementing EV charging stations and service provision** in GAM through a public-private partnership. This project aims at attracting investments to deploy slow and fast charging networks to respond to the growing service demand in the city of Amman.
- **The second is to develop and implement a national energy storage action plan and investment pipeline.** This aims at establishing a short-to-long term strategy to tackle Jordan's energy storage challenges, a key component in enabling the country's transition towards RE. The success of E-mobility depends substantially on storage systems, and ytherefore projected to be part of the strategy.

Jordan Energy Strategy (JES) 2020-2030: The overarching objective of the JES and action plan for the years 2020-2030, sponsored by the ***Ministry of Energy and Mineral Resources (***MEMR), is to "foster expansion of adopting electric mobility modes". JES includes strategic actions to

Among a slew of seven planned actions are establishing a low-carbon municipal fleet for Zarqa, Madaba, and Irbid; designing and implementing a public electric mobility pilot project in Amman; supporting the deployment of ITS for the transport sector; and scaling up the provision of public-school bus services in all municipalities.

establish a reliable charging network and incentivize the adoption of EVs for private, public and governmental fleets. The plan also includes a project to "enhance transport modes and establish the BRT networks and a rail network" – without specifying whether electric or not – as a means of enhancing energy security and reducing the reliance on external imports to meet the country's energy needs. The implementation of BRT and rail projects depends on the availability of financing.[83]

Furthermore, at the subnational level, several strategies and plans have been developed as follows:

Greater Amman Municipality (GAM): GAM has developed several strategies and plans in responding to climate change and advancing a green city framework. The Amman Resilience Strategy promotes sustainable transportation through developing a smart, resilient and environmentally friendly city[84]. The strategy proposes several interventions related to the transportation sector, including:

- Enhancing transportation systems, with public transport at their core.
- Developing a pedestrian-friendly city.
- Increasing EE and availability, by boosting the share of RE, advocating the use of EVs, and replacing the governorate's own fleet with an electric one.

Sustainable mobility is also one of the main pillars of the Amman Climate Plan. In order to achieve this goal, the plan proposes promoting EVs and showing leadership by electrifying the municipal fleet, prioritizing low-carbon transport modes, updating the transport and mobility master plan, and improving pedestrian and cycling infrastructure[85]. It also proposes the following actions:

- Develop clean, efficient, and widespread public transport
- Electrify the majority of taxis and private cars
- Improve walkability as a key mode of mobility in the city center

Aqaba Special Economic Zone Authority (ASEZA): ASEZA has also developed an action plan in response to climate change, and to promote a transition towards sustainable energy and development. Land transport accounts for 38.3 percent of the total energy consumption in ASEZA. Therefore, sustainable and low-carbon transport alternatives are given priority among private and public fleets.[86] ASEZA encourages investment in different sectors as a special economic zone through a stimulating legal and policy environment.[87]

Petra Development and Tourism Regional Authority (PDTRA): Petra is a sensitive ecological site, and one of the United Nations Educational, Scientific, and Cultural Organization (UNESCO)'s world heritage sites. Therefore, PDTRA emphasizes the importance of investing in an adequate, eco-friendly transport system. Low carbon and sustainable modes of transport, along with the deployment of renewable energy, are proposed to preserve and protect Petra from harmful emissions. As a special archaeological region, PDTRA has developed a set of enabling guidelines and regulations to promote national

and foreign investments in the region[88]. The Authority has deployed two pilot electric buses in the city.

Karak Municipality: Karak Municipality in the South of Jordan has developed Sustainable Energy and Climate Action Plan (SECAP). Transport accounts for 28.25 percent of the total energy consumption in Karak, hence low carbon transport is a climate priority. The plan consists of several awareness raising programs to cut down emissions and encourage eco-friendly transport practices[89].

Greater Irbid Municipality: Greater Irbid Municipality (GIM) in the North of Jordan has also developed a SECAP. The action plan proposes projects to enhance the public transport sector, cut emissions, and reduce energy needs. This includes the replacement of the municipal fleet of all types with EVs. As the third most populated governorate in Jordan, Irbid has commited to reducing its emissions by 40 percent by 2030 compared to 2015 [90].

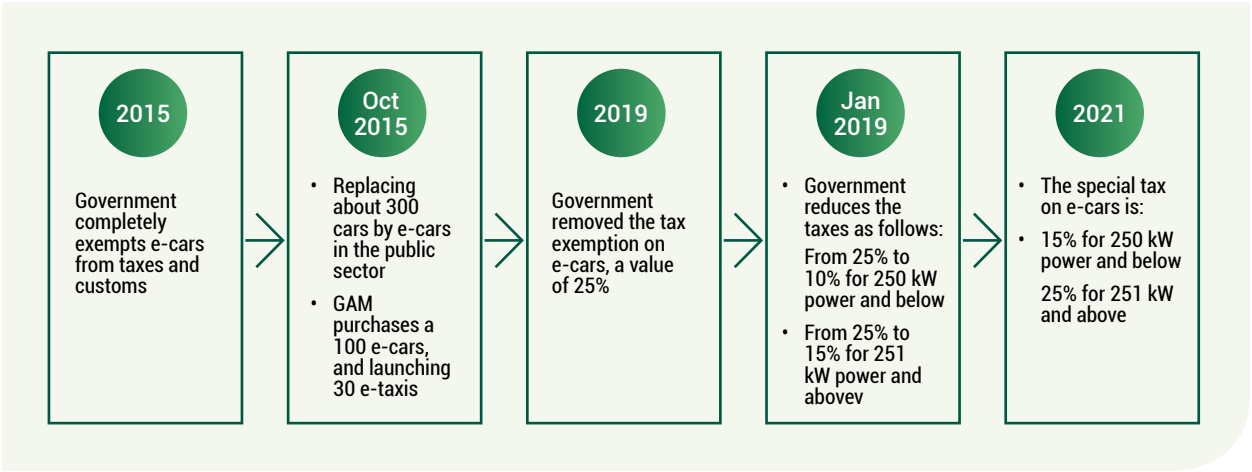
Charging infrastructure and the enabling environment

This section discusses the key aspects of the enabling environment for e-mobility in Jordan in the backdrop of the aforementioned national and sub-national strategies yet to be translated into sufficient actions. Most of the country's focus has been on cars rather than buses in the present early stage.

E-mobility has received growing attention from both public and private actors in Jordan over the past few years. The MEMR and the MoT have recently formed an inter-ministerial committee on e-mobility, in cooperation with other key stakeholders such as MoEnv and EMRC. The committee investigates the current legal and regulatory framework, identifies gaps and challenges, and explores potential projects and partnerships that can benefit the sector. MEMR is currently taking the lead of this committee along with the overall leadership of the e-mobility strategy under the umbrella of the updated JES 2020-2030, wherein the e-mobility strategy is articulated as a clear priority)[91].

Although Jordan has a track record of putting incentives in place for EVs, the incentives were largely meant for electric cars and not buses. These started in the form of complete custom duty and tax exemptions in 2015, but have been fluctuating and unstable since, to a series of unsettling fluctuations (see **Figure 13**), greatly impacting the investment environment[92]. In terms of charging infrastructure, only 18 licenses for electric light-duty charging stations have been issued by EMRC across the nation to date.

Figure 13: Timeline of incentives for electric cars development in Jordan, none for buses yet



EMRC has granted licenses for electric light-duty charging stations distributed across Jordan; 10 of them are inside Amman.[93] A study conducted by GGGI in 2018[94] indicated that there are 5 more charging stations dedicated to Tesla cars only, but not listed on the EMRC website. In 2016, EMRC issued guidelines on licensing of EVs charging activities, with support from the USAID Jordan Competitiveness Program (JCP). Licensing is required for the charging activity of every vehicle, private or commercial, as the guidelines set the framework for owning, installing and operating charging stations. Charging stations could be connected to either the electricity grid or RE source in coordination with respective electricity distribution companies. Additionally, EMRC is responsible for all control and inspection activities, including ensuring adherence to the guidelines, identifying violations, and the eligibility of individuals/entities who operate and install charging stations.

Multiple initiatives and partnerships are in process to install DC fast charging stations at gasoline stations, of which Jo Petrol and Manaseer are two examples. Private sector players indicate that the low profit margin of 37 fils/kWh (52 cents/kWh) set by EMRC is turning away investments in fast DC charging stations. To overcome this, charge point operators, such as ION in Jordan, opt for cheaper Level-2 AC chargers because EMRC has set the same tariff for DC and AC chargers [95]. Otherwise, privately owned home charging points are prevalent under EMRC [96] regulation.

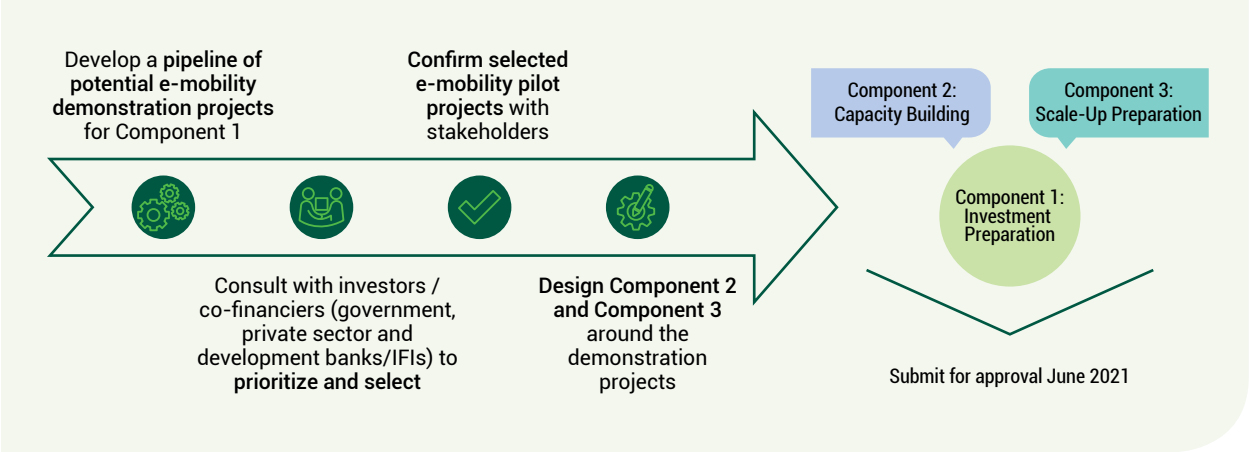
In the meantime, there has been only a limited advancement in strategic planning with regards to electric buses. But a solid step forward is an upcoming project discussed in the following section that promises adequate support in planning for electrification in public transport in a systematic manner.

UNIDO Project

Integrated Adoption of Electric Mobility is a project currently being implemented by the United Nations Industrial Development Organization (UNIDO), expected to start in Q3 2022, with support from the Global Environment Facility (GEF). It aims to accelerate the deployment of e-mobility in Jordan through the innovation and knowledge transfer. The project is being implemented in partnership with GGGI as an executing entity, and in cooperation with public entities, including the Ministry of Planning & International Cooperation (MoPIC), MoEnv, MoT and MEMR. The project has USD 1,137,215 as total projected budget; USD 6,200,000 in co-financing; Project Preparation Grant (PPG) of USD 50,000 (without IA fee)[97]. It has three components summarized as follows, and further described in **Figure 14** [98]:

1. Under E-mobility demonstration project preparation, this component identifies:
   a. Public transport projects
   b. Private transport projects
   c. E-mobility financing facility
2. For Policy coordination and capacity-building, this component includes:
   a. Policy and institutional coordination
   b. Project development and implementation capacity
   c. E-mobility technical training
3. In preparation for scale-up and replication, this component includes:
   a. Policy analysis and revision
   b. Socio-economic impact assessment and gender mainstreaming
   c. Design of impact mitigation measures

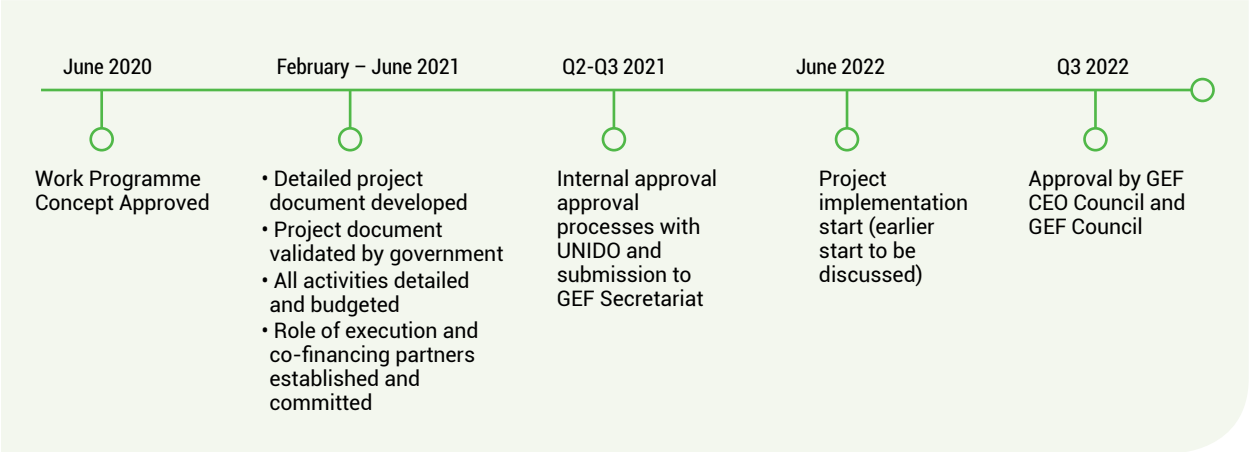
Figure 14: Integrated Adoption of Electric Mobility Project Components



(Source: GGGI, UNIDO, 2021)[99]

The project concept was approved in June 2020, while implementation is anticipated to start in the third quarter of the year 2022. Further details on the project's timeline are shown in the figure below.

Figure 15: Integrated Adoption of Electric Mobility Project timeline (as of Jan 2020).



Source: GGGI, UNIDO, 2021

In other notable activities by development partners, there is also a developmental project funded by the Federal Republic of Germany and implemented by GIZ in several partner countries, including Jordan, during the period 2014-2022. It aims to support partner countries in developing Decarbonization strategies across different sectors to help mitigate climate change. Recently, a workshop on *"Assessing the Socio-Economic Impact of Green Development Policies in the Jordanian Transport Sector"* was organized as part of the project activities. It proposes the use of models to design a low carbon transport sector for Jordan to support well-informed decision making and capacity-building activities needed in cooperation with development partners[100].

Also worth noting is a prospective Green Climate Fund (GCF) project that was pursued for financing. A project concept note targeting the cities of Irbid, Zarqa, and Madaba was developed, involving the introduction of low-carbon bus fleets in public transport. The concept note for this project was prepared on behalf of LTRC in order to seek funding through the GCF[101]. This planned intervention has also been recognized as a priority action by the Transport Sector GG-NAP (2021-2025) and priority list of NDCs issued by the Government of Jordan in 2020, with a further concept note development by GGGI through the Cities and Villages Development Bank in 2020. Yet, the project has not secured any financial support.[102] The LTRC has attempted to shift the focus of this project to the southern governorates of Karak, Maan and Aqaba, given that the northern governorates are undergoing a more general study to determine public transport feasibility in coordination with EBRD. The LTRC is still seeking support from an accredited entity to take forward the concept note for this project. This project could also be considered under the Nationally Appropriate Mitigation Action (NAMA) climate financing modality.

4.3 Legal and regulatory framework for bus fleets and systems

This section discusses the legal and regulatory framework and the mandates of the key public transport authorities relevant to public transport bus fleets and prospective charging infrastructure. Public transport in Jordan is regulated under various jurisdictions. Specifically in the case of the Greater Amman Municipality it is governed by the municipality authority. For the capital, the Aqaba Special Economic Zone Authority (ASEZA) in Aqaba is the regulator, and the rest of the nation falls under the Land and Transport Regulatory Authority (LTRC) with mandates as follows:

- LTRC is responsible for the following throughout the country, *except for GAM and ASEZA jurisdictions*:
  - Specifying public transport routes
  - Setting fares of specific routes and costs
  - Issuing license for public transport operators
  - Issuing license for other types of transport such as tourism, rental, taxi, and public-school and universities transport for fleets across Jordan.
  - Issuing permits for vehicles to operate in public transport along with rental and tourism.
  - Regulating public transport
  - Regulating public transports on routes connecting governorates.
- GAM and ASEZA are responsible for all aspects of public transport within their regions, including:
  - Specifying public transport routes
  - Setting fares for specific routes
  - Issuing license for public transport operators
  - Issuing permits for vehicles to operate in public transport
  - Regulating public transport within their boundaries

The private sector owns and operates the public transport fleet, with over 85 percent of operators being individual owners. The vast majority of individually owned buses are medium-sized buses consisting of 24-26 seats. It should be noted that the transport authority defines medium-sized buses as 9-30 seater, including the driver's seat.[103] Also, the current tax law indirectly encourages individual ownership of public transport vehicles, since it imposes higher taxes on larger companies in the form of civil responsibility compensation in comparison to individual owners[104].

LTRC is also responsible for regulating incentives provided for renewing old buses and other public transport fleets. LTRC also determines fares according to a formula developed to address several factors, and in line with a profit margin for operators. However, the formula is considered unfair for all operators due to differing passenger demand on different routes.[105] The operational life of public transport vehicles differs with sizes – 20 years for large-buses (over 30 seats), 15 years for medium-buses (9 – 30 seats), and 12 years for passenger cars[106]. However, in practice the current average operational age of public transport fleets is 10.6 years[107]. Regulation of tourism, school and university transportation is also under the LTRC.

According to a recent study, LTRC faces the challenge of human resource capacity to fulfill its broad mandate in the transport sector[108].

The issue of subsidies is intrinsic to governmental commitment towards going green. But in Jordan, governmental subsidies for public transport are almost non-existent. However, routes that are subsidized are those that serve public universities located in remote areas across the country. Students of Al-Hussein University, the Jordan University of Science and Technology, Aal Al-Bayt University, and the Hashemite University are the only beneficiaries of these subsidies[109].

Public transport in Jordan is regulated under various jurisdictions. Specifically in the case of the Greater Amman Municipality it is governed by the municipality authority. For the capital, the Aqaba Special Economic Zone Authority (ASEZA) in Aqaba is the regulator, and the rest of the nation falls under the Land and Transport Regulatory Authority (LTRC).

Key relevant legislation and guidelines is noted as follows:

- **Traffic Law (No.49/2008)**[110]: The law was released by MoI and defines the regulatory framework for traffic, and licensing for drivers and vehicles.
- **Passenger Transport Regulatory Law (No.19/2017)**[111]: The law was released by LTRC, which comes under MoT, defining the regulatory framework for the public transportation of passengers. This law requires individual operators to merge with transport companies within a five-year period from the date the law was enacted. The objective is to promote service quality because individuals would need to adhere to trips timings, fares, and routes. Furthermore, the law aims at emphasizing decentralization in the sector by shifting some of LTRC responsibilities to municipalities or a special entity within municipalities to enhance service quality. Additionally, under its mandate, it seeks to create a Passenger Transport Supporting Fund to support operators and companies working in the sector to establish enhanced quality and improve adherence to laws and regulations in return.[112] However, according to the Bus Owners Association (BOA), the law's implementation is weak and needs further commitment from the government[113].
- **Municipal Law (No.41/2015)**[114]: The law was released by the Ministry of Local Administration (MoLA) and consists of 76 articles to set the framework for municipalities. Article "5-A" of the law defines municipal roles, assigning them the responsibility of public transport: *"To contribute to the development of public transport networks within municipal boundaries, define and establish stops for transport vehicles, set, organize and assign routes, and participate in determining the amount of its tariff when appropriate within the municipality, by taking into account the provisions of other laws."*
- **Guidelines on EVs Charging Activities Licensing (No./2016)**[115]: The guidelines were issued by EMRC in 2016 under the mandate of **Electricity Law (No.64/2002**). They provide the regulatory framework to own, install, and operate charging stations for both public and private usages. The guidelines reference EVs in general, but they are largely used for e-cars.

In review of the regulatory and legal framework, it is still predominantly suited to cater to conventional ICE vehicles without explicit interventions to cater to electric buses. Even when there are specific EV considerations, in the guidelines for EV charging for example, these are focused on light-duty vehicles. This presents a significant opportunity for improvement in the coming stages of development.

LTRC's main mandate is regulating public transport rather than operating it. As an exception, GAM and ASEZA are responsible for regulating public transport systems within their boundaries. Further to LTRC, GAM and ASEZA, the Ministry of Transport (MoT), and Central Traffic Department also have relevant regulatory functions. Coordination among them is still modest however, with some overlap in their responsibilities[116] and efforts are on to address this gradually. Further details of these entities are described in section 4.4.

Amman benefits from the operation of two main companies in its governorate – Comprehensive Multiple Transportation Company (CMTC) "Al-Mutakamilah", and Amman Bus. Both have relatively higher service quality than traditional fleets, including such facilities as electronic fare collection and vehicle tracking system connected to a passenger mobile application. Individual operators accounting for the majority of operators are unable to provide such service levels.

4.4 Stakeholder assessment

This section presents key stakeholders within Jordan's e-mobility landscape, including public, private, development, and non-governmental organizations, with an overview of their main roles and responsibilities.

Key public stakeholders

The following section discusses the key public stakeholders and indicates their relevance to e-mobility / e-buses in Jordan.

Ministry of Energy and Mineral Resources (MEMR)

Responsible for developing the country's national energy strategy and action plan, the Ministry of Energy and Mineral Resources (MEMR) also issues laws and regulations related to the energy sector. The ministry has recently stepped up to lead the transition to e-mobility for Jordan in close cooperation with relevant stakeholders such as MoT.

- **Energy and Minerals Regulatory Commission (EMRC)** operates under the authority of MEMR and regulates the energy sector by issuing licenses for individuals and entities working in the field, in addition to issuing guidelines / licensing for EV charging stations and overseeing the work of electricity distribution companies. It is also responsible for setting electricity tariffs for different usages including commercial chargers.

Ministry of Transportation (MoT)

MoT is responsible for developing transport sector strategies through studies and research aimed at further strengthening the sector in line with national priorities.

- **Land Transport Regulatory Commission (LTRC),** a regulatory body linked to MoT, is responsible for applying strategies and policies in relation to the sector and operating its framework. LTRC is responsible for regulating the transportation sector across the country, except in Amman and Aqaba.

Ministry of Environment (MoEnv)

The ministry sets Jordan's environmental priorities and coordinates the update of Jordan's GHG inventory and national communications to the UNFCCC – capturing information in the Monitoring Reporting and Verification (MRV) system as needed. The Ministry also promotes the transition to low-carbon and environment-friendly modes of transportation – through Transport GG-NAP and the

Drivers and Vehicle License Department (DVLD,) the Ministry is responsible for vehicle inspection and licensing. It also issues driving licenses for drivers of all categories. Another arm, the Central Traffic Department, is responsible for implementing the traffic law and the public policies for regulating traffic and transport in Jordan. This includes accident investigation and imposition of fines.

NDCs. MoEnv also led the initiative to introduce tax and customs exemptions on e-cars, and engagement with other stakeholders like GAM and the private sector.

Ministry of Planning & International Cooperation (MoPIC)

The Ministry leads the formulation of national socio-economic frameworks like the Government Indicative Executive Program (GIEP), the JEGP and the reform matrix, overseen by a Project Management Unit initially established for this purpose under the USAID Jordan Competitiveness Program. MoPIC also coordinates the implementation of these frameworks with other stakeholders in the public and private sectors, as well as international partners. The recently launched project by UNIDO and GGGI mentioned above in 0 are examples. The ministry has advocated for e-mobility in its local development strategies. It also houses the Public Investment Management (PIM) Unit which is the starting point for both public and private investments in all sectors including transport – coordinating with the PPP Unit at the Prime Ministry as needed.

- **Department of Statistics (DoS)** is linked to MoPIC and is responsible for producing, analyzing, and disseminating data across the public sector. DoS applies improved techniques and statistical methods in line with best practice to meet the needs of stakeholders. It also aims at improving the performance of Jordanian statistical system components. The department provides statistics on the state of transport and EVs in Jordan, for instance, DoS provides statistics and breakdown on the numbers of different types of vehicles across the country, including EVs.

Ministry of Public Works and Housing (MoPWH)

The Ministry plans and outlines the infrastructure of the sector. The plans include construction, maintenance and safety of roads.

Ministry of Interior (MoI)

Through its arm, Drivers and Vehicle License Department (DVLD,) the Ministry is responsible for vehicle inspection and licensing. It also issues driving licenses for drivers of all categories. Another arm, the Central Traffic Department, is responsible for implementing the traffic law and the public policies for regulating traffic and transport in Jordan. This includes accident investigation and imposition of fines.

Ministry of Local Administrations (MoLA)

The Ministry holds authority over municipalities and local administrations in Jordan. It works towards decentralization and empowering municipalities, so that they might be tasked with transport regulation within their boundaries at future stages.

Prime Ministry (PM)

It plays a role in supporting efforts towards decarbonization mainly through developing the government's priorities of action. The PPP Unit, as an arm of the PM, plays a major role in developing an adequate legal environment for investments and facilitating implementation.

Petra Development and Tourism Regional Authority (PDTRA)

PDTRA is an independent financial and administrative public authority that aims to develop the region in almost all sectors. PDTRA acquired the first two e-buses in Jordan as a pilot, and is currently looking for expansion. For instance, the archeological site of Petra is projected to need 10 buses to operate a satisfactory transport service.

Greater Amman Municipality (GAM)

GAM is responsible for regulating public transport in Amman, alongside other municipal services. It also provides the regulatory framework for individual operators. GAM owns private investment arm, Amman Vision, and is currently in the process of developing a BRT system with support from the French Development Agency, AFD.

- **Amman Vision Investment & Development (AVID),** also referred to as "Amman Vision", is an investment company fully owned by GAM. It has been established in line with Jordan's Vision 2025. Amman Bus is considered one of the company's main investments, which plays a vital role in developing public transportation services in Amman. It is currently deploying phase 2, including 15 full-electric buses.

Aqaba Special Economic Zone Authority (ASEZA)

Aqaba is responsible for regulating the transport sector within Aqaba. ASEZA is considered an independent and decentralized authority presiding over the Aqaba governorate, with a stimulating regulatory environment for investment. ASEZA plans to integrate low-carbon transport planning in its future expansion and development.

Key private sector stakeholders

The following section outlines the key private stakeholders and their relevance to electric mobility in Jordan. Since a bigger commitment from the private sector is yet to be seen with a clearer focus on electric buses, the list herein includes both kinds of private players – those involved in electric cars charging as well as those open to prospects of catering for bus fleets electrification with adequate incentives. This does not include Aramex, which already deploys e-vans.

Manaseer Group: This is a leading private company in Jordan that owns and operates an extended chain of gas stations. The company established several fast-charging points at their gas stations, and intends to expand their charging network within their current and new gas stations to service e-cars to date.

CATEC: This is a private company that provides charging solutions for electric cars to date, parking spaces, and power capacity. The company has established several partnerships in Jordan to provide its services.

ION: This is a local start-up that provides charging solutions through manufacturing and providing level 2 charging networks.

Aramex: One of the leading logistics, courier and package delivery companies in Jordan and the region, Aramex introduced e-vans in Amman in 2017. It is currently looking for expansion considering their successful experience with fleet electrification. Aramex case study is discussed in section 4.8.

ELBA House: The only bus manufacturing company in Jordan, ELBA has extensive experience in bus-body manufacturing according to international standards. However, Elba has not announced any future plans for bus electrification.

Key development PARTNERS

This section gives an overview of the key development partners and indicates their relevant activities in Jordan.

Global Green Growth Institute (GGGI): GGGI works in close coordination with MoEnv – where it is located – to strengthen national, sub-national and local green growth planning, financing and institutional frameworks, including the National Green Growth Plan and related sector plans like the GG-NAP for transport and energy. GGGI is also the executing partner of UNIDO project, "Integrated Adoption of Electric Mobility project in Jordan".

United Nations Industrial Development Organization (UNIDO): Currently, UNIDO is implementing the Integrated Adoption of Electric Mobility project in Jordan, which aims at deploying e-mobility through innovation and knowledge transfer.
French Development Agency (AFD): AFD financially supports the implementation of the BRT project in Amman. AFD is financing around two-thirds of the project's estimated cost of USD 250 million.

European Bank for Reconstruction and Development (EBRD): As part of the EBRD Green Cities initiatives, which includes Amman, EBRD is financing the deployment of the second phase of 'Amman Bus'. This includes 136 Euro V diesel buses and 15 e-buses in cooperation with GAM.

World Bank (WB) WB supports Jordan in multiple development areas, including implementation of the reform matrix and in providing technical assistance to advance Jordan's climate change priorities. Setting up the region's first Monitoring Reporting and Verification (MRV) framework for tracking of GHG emissions is one such initiative. The Bank is also embarking on a regional study to assess the EV potential in Jordan and other countries in the region, as well as an upcoming *Program4Results* with a total of USD 750 million. To be taken up in cooperation with the MoEnv and MoPIC, a large focus of these projects would be on green climate-responsive sectors.

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ): GIZ aims to support sustainable development in Jordan in multiple sectors, along with providing support to refugee communities. GIZ has been contributing to enhancing the transport sector in Jordan for local communities. The *Policy Dialogue and Knowledge Management on Low-Emission Development Strategies Project* and *Trade for Employment (T4E) Project* are examples of their work.

Friedrich Ebert Stiftung (FES): FES organizes conferences and workshops, conducts research and prepares policy papers regarding issues in the transport and energy sectors, with a focus on gender and climate aspects. It organized an e-mobility knowledge exchange trip to Germany and developed several information products on e-mobility to contribute to awareness-raising, capacity-building and experience exchange. It collaborated with Sadaqa NGO to release a study on gender and mobility, and is currently advancing a Gender Action Plan in cooperation with academics from the University of Jordan.

There are also other local NGOs that contribute to stakeholder awareness and to promoting e-mobility, although mostly focused on cars. *Ma'an Nasel, Electric Vehicles Association,* and *EDAMA NGO* are a few examples. The *Bus Owners Association (BOA),* another significant non-governmental stakeholder, makes a common cause of bus owners and operators in the public transport sector, communicating issues of concern to the relevant governmental entities.

Other private bus companies and fleet operators

As mentioned previously, the vast majority of public transport operators are individuals. However, there are a number of private companies that operate in the transport sector. These include tourist, rental and public transport companies, such as the following:

- **The Jordan Turkish Company** is a joint venture between CMTC (Al-Mutakamilah) and Gursel. The company is responsible for operating **Amman Bus.**
- **Jordan Express Tourist Transportation Company (JETT)** is identified as a tourist transport company. Its main routes are Amman-Aqaba and Amman-Irbid.
- **Jordan Bus Company (Sariyah)** is also a tourist transport company. The company's main route is North Bus Station-QAIA.
- **Rum Jordan** is a tourist transport company that operates trips to different tourist sites in Jordan.
- **Tarek Alhakaya** is a rental bus company. it also operates on fixed routes such as North Bus Station-Jordan University of Science and Technology.

4.5 Market overview and situation analysis

This section primarily presents an overview of the public transport bus market, as well as an overview of the existing e-mobility cases in Jordan. This includes electrification prospects in existing projects or those planned in future.

Market size and key players

There are 26,526 buses in Jordan as per the Department of Statistics (2019), with the largest fleet of 16,982 buses of various types and sizes operating in Amman. The bus fleets in Jordan are predominantly powered by diesel, which are not comparable to international vehicle and fuel standards. Buses are of different sizes ranging from 7m to 12m. The average operational age of the public transport fleet in Jordan was estimated to be10.6 years by the end of 2020.

Table 9: The total number of buses (7m to 12m) in Jordan and in Amman governorate as of 2019

Type	Private vehicles	Public vehicles	Total
Buses in Amman	12,535	4,447	16,982
Buses in Jordan	17,777	8,749	26,526

Source: DoS, 2019

The Bus Owners Association (BOA), another significant non-governmental stakeholder, makes a common cause of bus owners and operators in the public transport sector, communicating issues of concern to the relevant governmental entities.

Public transport fleet

The public transportation system in Jordan still faces challenges in terms of coverage and reliability. According to the Land Transport Regulatory Commission, the number of buses per 1,000 persons is 0.7 buses, a considerably low rate. In comparison, many cities have double this figure[117,118]. The sector has considerable room for development and expansion.

In order to provide a reliable transportation system in Amman, additional 3,500-4,000 buses are needed, according to estimates by AVID. Hence if the 15 e-bus pilot as part of the second phase of Amman Bus is successful, there is still considerable room for the deployment of e-buses in the city[119]. PDTRA also indicated that 20 additional buses are needed to operate in the archeological site of Petra for tourism purposes. ASEZA too has noted that the city of Aqaba is currently expanding in the northern region of the governorate. Therefore, there is potential for a significant increase in demand for public transport prompting ASEZA to express interest in e-buses[120].

Although 85 percent of public buses operators are individuals, there are several companies working in the transport sector. Larger companies are more likely to adopt e-buses with the right incentives and business models. According to LTRC, the overview of the licensed companies is as follows:

- Bus Rental Companies: 16 companies
- Tourist Bus Companies: 6 companies
- Public Bus Transport Companies: There is limited data on the number of companies providing public transport services. However, several tourist and rental companies provide services as public transport on specific routes such as JETT and Sariyah, which fall under the mandate of LTRC. These are In addition to government-owned transport companies such as Amman Bus and Aqaba Transport company, which fall under the mandate of GAM and ASEZA respectively.

The following table provides information on several transport companies in Jordan. These include leading intra-city and inter-city transport companies operating on key routes.

Due to the high upfront cost of e-buses, the private sector, consisting mainly of individual owners, is less likely to shift towards e-buses. However, proper incentives and lower taxes on e-buses would play a significant role in promoting electrification of public transport. The business model of Amman Bus is a good example in this regard. The company, though under the ownership of the government (GAM), has a private company running its operations. Such a business model can be developed through governmental policies and financial reforms, which are critical for enhancing the public transport sector and enabling potential fleet electrification. Further details on Amman Bus are provided in section 4.7.

Table 10: Transport companies operating in Jordan

Company	Type	Fleet (Buses)	Comments
Amman Vision	Government-owned (intracity)	135 soon to add 151	15 of the 151 buses are e-buses
CMTC (Al Mutakamilah)	PPP (inter/Intra-city)	600 (only around 250 are in operation)	60% of their operation on universities routes
Aqaba Transport Company	Governmental (intracity)	70	Owns and operates public bus fleet in Aqaba
Jordan Express Tourist Transportation Company (JETT)	Private (intercity)	more than 220	Main routes: Amman-Irbid Amman-Aqaba
Jordan Bus Company (Sariyah)	Private (intercity)	200	Main route: Amman-QAIA

Although public transport is the focus of this study, it is also worth noting the buses for public school transport are receiving significant attention in Jordan and can be an area of intervention. Public schools in Jordan lack a formal transportation system for students.

As a means of regulating this sector and solving this issue, LTRC conducted a study to identify the number of buses needed to serve students of public schools, particularly students between ages of 6 years-13 years who lack access to public transport. The study noted that 20-seater buses would be the most adequate for this purpose, and the number of buses needed is as follows[121]:

- The northern province of Jordan: 3,129 buses
- The Middle province of Jordan: 1,146 buses
- The southern province of Jordan: 5,085 buses

Charging infrastructure and costs for e-buses

Public charging infrastructure in Jordan is a regulated market. The EMRC determines regulation and standards for the installation and operation of the charging stations. According to Article No. 3 of the guidelines for charging practices released in 2016, it is not permissible for any person to establish, own, manage or operate a charging

A project of 15 e-buses is being planned by Amman Bus, discussed in the in the following sections, for which the e-buses are expected to be charged overnight through dedicated chargers at the North Bus Station. For the two e-buses in Petra, four chargers have been installed in different locations across the city dedicated for them.

station for electric vehicles without obtaining a permit or license issued by the authority.

The authority grants permits and licenses in accordance with the guidelines regulating the activities of public and private charging stations for EVs. It should be highlighted that EMRC guidelines provide for charging activities for "electric vehicles". However, there are no specific conditions for e-bus charging infrastructure.

Electricity retail prices are determined by EMRC and are currently set at a value of 147 FLS/kWh (~21 cents/kWh), while the purchase price is set at 110 FLS/kWh (~16 cents/kWh). It is notable that the current commission of 37 FLS/kWh (~5 cents/kWh) is not financially attractive for investment. This negligible profit margin is a formidable challenge for investment into large-scale charging infrastructure. However, the newly formed e-mobility committee working under the MEMR acknowledges this issue and seeks to address it in future policy reforms.

There have not been any governmental steps to integrate e-bus charging infrastructure into future plans and to deploy it for public use on a large scale. A project of 15 e-buses is being planned by Amman Bus, discussed in the in the following sections, for which the e-buses are expected to be charged overnight through dedicated chargers at the North Bus Station. For the two e-buses in Petra, four chargers have been installed in different locations across the city dedicated for them, also discussed in the following sections

Information on Procurement and operation costs

Even though TCO analysis is not in the scope of this preliminary study, an indicative overview of key cost categories is presented in this section for perspective, and to facilitate comparison with other countries. The information is obtained through direct communication with existing e-bus owners in the country and the average market prices obtained through the case studies investigated.

Table 10 below summarizes price and other characteristics of the existing and available electrical vehicles common in Jordan. The cost of existing full-electric Hyundai buses deployed in Petra is USD 282,000, given the granted exemptions from custom duties and taxes, specifically for PDTRA. For the sake of perspective, it is notable that a large diesel bus in Jordan – the prevaili ng 12m Euro-V Otokar diesel bus for example – costs USD 211,000, including the custom duties of15 percent and 16 percent tax exemption. Before the imposed levies, the price of the electric bus would be about 1.75x the price of the diesel bus, and probably about double compared to a diesel bus with more passenger capacity.

Table 11: Cost and specification of selected examples of common EVs in Jordan

Example	Manufacturer	Battery Capacity (kWh)	Price	Tax and custom	Comments
Full-electric Bus (11 meter)	Hyundai	256	200,000 JOD (282,000 USD)	Exempt from 16% taxes Exempt from 30% custom duties	Custom made, price as of 2019, as obtained from PDTRA (owner) *Tax and customs exemption is specifically for PDTRA
E-Van	BYD	46	28,000 JOD (39,000 USD)	Including 16% taxes Exempt from all custom duties	New, purchase price in 2017, as obtained from ARAMEX Jordan.
Electric car	Nissan Leaf	40	25,000 JOD (35,200 USD)	Included Tax = 15 %	New, purchase price in 2021 (manufacturing year: 2020)

However, there are significant difference between diesel costs and the electricity costs, which makes the operating cost of electric vehicles per kilometer just about half that of the diesel vehicles. Therefore, other than tax exemptions, there are further cost savings that accrue with high usage.

TCO for chargers and establishing charging stations vary from one company to another, depending on the type of the charger and the infrastructure required. However, based on direct consultation with PDTRA, which account for the only e-bus charging stations in Jordan, their chargers have the following specifications:

- Type: Raption 150 CCS2
- Capacity: up to 150 kW
- Charging points: one
- Capital cost: 47,000 JOD (66,000 USD) – 16% sales tax included
- Date purchased: 2019

However, as projects may scale up, further costs must be considered in terms of grid reinforcement needs. Alternative charging strategies and technologies may also be deployed, substantially affecting the charging infrastructure costs.

4.6 Case study: Bus-Rapid Transit (BRT) system

This section provides an overview and analysis of the BRT project in Jordan. It also discusses the attempts at electrifying it and the existing challenges.

Background

The BRT system in Amman and Zarqa will be the first-of-its-kind large-scale public transport project in Jordan. The BRT involves high-capacity buses running on special and segregated lanes to ensure high efficiency and quality of service for users – with buses running with headways down to 3 minutes along Amman's busiest corridors. It involves two projects, one within Amman, and the other between Amman and Zarqa.

Firstly, in Amman, the project will build two BRT corridors with a total length of 25 Km, at a total cost of USD 250 million of which two-thirds is financed by the AFD. With approximately 140 articulated buses in operation[122], it is expected that more than 315,000 passengers per day will benefit from the BRT services.

Secondly, in the Amman-Zarqa BRT corridor, the project will connect the two governorates over a total distance of 20 m, and a total cost of approximately USD 200 million funded by the Social Security Investment Fund (SSIF).

Project overview

The BRT project originated in 2008 and faced many interruptions in implementation. Currently, the project is being implemented between Amman and Zarqa, and within the Amman governorate. There have been some attempts to electrify the BRT, particularly with support from MoEnv and GGGI by proposing to leverage climate finance. Funds like Green Climate Fund (GCF) can support in covering the extra cost associated with electrifying the BRT, particularly related to the higher capital price of e-buses and the infrastructure needed for charging stations.

The Greater Amman Municipality was made aware of the advantages of electrifying BRT because of an extensive study by MoEnv through GGGI in 2018. GAM's initial response to the transition towards e-mobility was that of one fraught with risk on account of Amman's hilly topography, project delays, and the relatively new technology of e-buses. However, the Municipality is considering the potential of electrifying specific routes in the second phase of the BRT project[123].

GGGI has proposed several bus options to operate the BRT system such as trolleybus, fully electric, plug-in hybrid, and hybrid buses. According to the GGGI's study, the most feasible options for the BRT are fully electric buses with fast chargers or trolleybus system; further assessment is needed to define the best choice based on infrastructure and grid analysis.

For the feeder bus system, GGGI assessed both fully electric buses and hybrid buses, and strongly recommended fully electric buses as the most viable option from an economic standpoint when including the cost of pollution. However, further investigation is required to identify the best charging strategy. The GGGI proposal for GAM for electrifying the BRT – trunk routes and the feeder buses – includes several assumptions summarized in the table below[124].

Table 12: Assumptions for BRT electrification proposal

Assumption	Value	Comment
Size trunk buses	18m	High capacity trunk route; 160 passengers per bus
Size feeder buses	12m	Standard buses; 80 passengers per bus
Amman Trunk route length	19 km	Information provided by GAM; 1-way
Number of stations per way	38	Based on 500m between each station
Number of trunk buses	68	Speed of 25km/h; run time 46 minutes (distance/speed) per direction; stand time both sides 5 min.; total cycle time 102 minutes; headway 1.5 minutes; Peak Vehicle Requirement (PVR) =cycle time/headway;
Number of feeder buses	50	Assumption for calculation purposes
Share reserve buses	10%	Standard value
Annual distance trunk bus	80,000 km	Average of multiple BRT systems
Annual distance feeder bus	60,000 km	Average of multiple BRT systems
Euro standard	IV	See baseline bus
Commercial lifespan of bus	12 years	20 years for trolleybus incl. TOSA; BEBs 16 years (2o battery cycle) due to less vibrations and bus wear

Source: GGGI, 2018b

Cost unbundling plays a major role in promoting EVs. In order to estimate the TCO of e-buses, GGGI took into consideration the capital cost, fuel savings, running cost savings, and savings related to reduction of GHGs, particulate matter (PM), NOx, and their monetary impact. For the BRT system, the report estimated a potential reduction in emissions (ton per annum) of 11,133 tons CO2 (Tank to Wheel), 0.5 tons PM2.5, and 61 tons NOx emissions. For the feeder system, it is estimated that deploying e-buses can potentially reduce 3,711 tons CO2 (Tank to Wheel), 0.2 tons PM2.5, and 24 tons NOx emissions per annum.[125]

Furthermore, it estimated the noise pollution to be around 50 percent less for e-buses than diesel buses. It is worth mentioning that the great impact is projected to be through GHG reduction, estimated to be around *60* percent lower in carbon emissions, given the electricity mix in Jordan[126]. The table below provides a financial comparison of low-carbon buses for BRT trunk route Amman conducted by GGGI based on 2017 data. It compares with a diesel baseline, Euro-IV bus. Results indicated that the financial and economic IRR favor the option of fully electric buses with opportunity charging for the BRT Trunk route in the case of 18m buses. Trolleybuses are also a suitable option that should be examined. The plug-in hybrid proved to be the least lucrative. It is important to note, however, that trolleybuses considered here are equipped with large batteries that allow mobility for substantial distances where the catenary is not available, thereby increasing their costs.

For the feeder bus system, GGGI assessed both fully electric buses and hybrid buses, and strongly recommended fully electric buses as the most viable option from an economic standpoint when including the cost of pollution. However, further investigation is required to identify the best charging strategy.

Table 13: Comparison of low carbon buses for BRT trunk route in Amman

Financial and Economic Calculations in 2017 USD	Diesel	Hybrid	Plug-in Hybrid	Opportunity Charge	Trolleybus
CAPEX bus	30,000,000	40,050,000	48,600,000	37,500,000	48,502,203
CAPEX bus infrastructure	0	0	1,314,000	19,314,000	17,756,000
Incremental total CAPEX		10,050,000	19,914,000	26,814,000	36,258,203
OPEX savings year 1		695,106	724,560	629,400	540,620
Economic savings year 1		136,316	169,711	277,908	277,908
Financial NPV		-4,496,176	-12,320,729	-14,003,309	-23,441,410
FIRR		-3%	-8%	1%	-2%
EIRR		0%	-6%	3%	-1%
MAC per tCO2 non-discounted (WTW)		43	186	-29	63
MAC per tCO2 discounted (WTW)		116	258	114	190

Source: GGGI, 2018b

In further results of the 2018 GGGI study, Battery Electric Buses (BEBs) and hybrid buses proved most viable in terms of low-carbon options for the *feeder* bus routes requiring 12m buses. GAM hired a private consulting firm to study the most feasible bus choice, and to provide decision making based on evidence, while acknowledging the risks and uncertainty associated with choices in fleet electrification. The study released a *Fuel Technology Report* that has not been published. However, a summary report was provided through direct consultation with GAM, where the key concerns are as follows indicating the prevailing perceptions[127]:

- E-bus technology is considered relatively new and therefore perceived as "risky". The cost analysis modelling provided for e-buses is not conclusive, and the benchmark material points of electrifying large fleets are yet to be proven.
- E-buses have to operate in Amman's unique environment and its mountainous topography; therefore e-buses need to be accordingly adjusted. In addition, there are other factors such as passenger loading rate as the BRT proposes more frequent loading/unloading. This means less time at terminals for charging, which could impact the range. Similarly, battery charge/usage is also perceived as a challenge in terms of location, cost, and time of charging.
- The support in terms of financial, technical, and policy reform is essential to minimizing the risk associated with operating EVs in public transportation. GAM would therefore need reliefs such as exemption for e-buses from tax and custom duties and incentives for electricity charging by way of lower tariff. These might be an important area for support from development partners in planning and implementation. Exempting e-buses from tax and customs, as in the case of the two e-buses in PDTRA, can go a long way in encouraging bus electrification.
- The low risk associated with diesel buses is noted; they are a known and understood technology and have proven efficiency in operation, in addition to reducing Nitrogen Oxides emissions by as much as 40 percent. The report proposes diesel (Euro V) buses as the most appropriate, practical, and implementable fuel technology for Amman-BRT (at this time) Several gas station chains such as Manaseer and Jo-Petrol already provide Diesel Euro 5.

On the other hand, taking into account the advances being achieved in the e-mobility sector, the report suggests planning for a small electric pilot study, with focus on the following:

- Substantial continued awareness-raising and capacity-building is needed among local authorities and policymakers on e-mobility, including most recent updates and international experiences. Original Equipment Manufacturers should also be engaged in capacity building and in technical support.
- Planning for e-mobility deployment could be initiated through a pilot project that would prove efficiency and reliability of e-buses. A potential pilot e-bus project was also suggested, linking Fountain Plaza in Al-Swaifyeh with Al-Mahatta station.
- Most e-bus pilot projects conducted internationally are being financially supported by international agencies, national governments, energy companies, and/or bus manufacturers. Therefore, Jordan should also seek benefit from such avenues of financial support, in addition to sources of climate and environmental finance.

Amman Vision Investment & Development (AVID) is a company fully owned by GAM, interchangeably referred to as "Amman Vision". It was established in 2018 in line with Jordan's Vision 2025 for growth and sustainable investment. AVID acts as a master developer of municipality-owned lands, properties, and investment portfolios.

Lessons learned to date

- Electrification is found to be not financially feasible yet in any studied scenario if not accompanied by additional climate financing to cover CAPEX differences, according to the study. It is also necessary to rather pursue TCO-based procurement decisions with enabling conditions – most notably the availability of suitable leasing schemes.
- Awareness-raising on the reliability of e-bus technology among decision-makers is needed.
- GAM concerns regarding the extra financial burden of electrifying the BRT can be addressed with support from green funds, according to GGGI.
- GAM might study electrifying a few routes in the second phase of the BRT.
- A pilot project showcasing e-bus technology would play a major role in advocating electrification among government officials. The upcoming 15 e-bus pilot under the Bus Amman project expansion is a good case in point.

4.7 Case study: GAM-AVID-Amman Bus

This section provides an overview and analysis of the existing Amman Bus fleet and the projected second phase of 15 e-buses.

Background

Amman Vision Investment & Development (AVID) is a company fully owned by GAM, interchangeably referred to as "Amman Vision". It was established in 2018 in line with Jordan's Vision 2025 for growth and sustainable investment. AVID acts as a master developer of municipality-owned lands, properties, and investment portfolios, as well as for offering investment partners access to several investment opportunities.

Amman Bus is considered a subdivision of Amman Vision, which holds authority over the Amman Bus project. The system provides a convenient transportation experience with ITS and electronic payments through prepaid and rechargeable cards. It is considered a one-of-a-kind governmental initiative that has successfully introduced a high-quality public transport system. All buses are equipped with tracking technology and monitored through a Vehicle Tracking System (VTS) by a special unit located in the North Bus Station. This unit detects any violation and penalizes the operating company, the Jordan-Turkish Company, as per the agreement signed.

The majority of routes operated by Amman Bus were originally under Al-Mutakamilah company's authority. However, the company waived its right of operating them to Amman Bus, due to financial constraints and the low passenger demand on the routes operated under Al-Mutakamilah.

Project overview

Amman Bus is considered one of the first governmental projects to own a public transport company under GAM. During the first phase, Amman Bus deployed 135 Euro V diesel buses on 27 fixed routes that cover 11 out of 22 areas affiliated with GAM. The second phase of the project, to be launched by GAM, would include 151 buses on 34 new routes. Of these, 15 are electric and the rest Euro V diesel buses. EBRD is the main financier of the second phase and the project is being conducted in close coordination with GAM and responsible authorities.

The EBRD is providing GAM with a financial package for the procurement of the new bus fleet. This would include136 Euro V diesel buses, including ancillary systems, to be purchased with a €20 million EBRD loan. The 15 electric buses will be financed with €5.6 million contributed jointly by EBRD and GCF, each financing €2.8m. Additionally, this financing is developed as part of Amman's participation in EBRD Green Cities program and is a follow-on investment

for Amman's Green City Action Plan (GCAP – soon to be launched by GAM).[128] The table below illustrates the key aspects of the second phase of the project.

Table 14: Amman Bus Second Phase Project Specification

Specification	Comment
Asset Owner (Fleet and Chargers)	GAM
Finance (Diesel buses)	€20 million (Provided by the EBRD): • €12 million unsecured sub-sovereign loan • €8 million a capex grant from the Community Resilience Sub Account of the EBRD's SSF
Finance (E-buses)	€5.6 million (Provided by EBRD & GCF equally) (The grant includes the charging infrastructure)
Operator	Private sector entity – yet to be determined (tender is currently out at the time of this report)
Grid analysis for charging stations	Requested at a later stage (it may be required by GAM or the bus operator, in coordination with the Jordan Electric Power Company / JEPCO along with any upgrades needed)

The following table provides the key specification of Amman Bus (e-buses & charging stations) as per the tender documents of the procurement of 15 e-buses listed on the EBRD website.

Table 15: Required specification E-buses & charging stations as per the tender documents[129]

Specification	Comment
Length	8,500-9,500 mm (+1%) (The bus should include 2 passenger doors)
Capacity	32-48 passengers (including seating)
Warranty	3 years (for charging stations) 8 years (for bus batteries)
Operating lifetime	Not less than 12 years (for both buses and chargers)
Travel distance/battery capacity	Minimum of 200 Km/charge (with all systems active and full passenger load)
Average operation per day	Minimum of 15 hours
Annual kilometers run per bus	Minimum of 85,000 Km
Charging time	The time needed to reach 80% state of charge should not exceed three hours on a rapid charging station.
Charging Stations	The total input power shall be a minimum of 80kW. With a minimum of 40kW of each charging port

Like the current fleet, the new vehicles are projected to reduce GHG emission and air pollution, while offering citizens easy, reliable, and safe commutes around Amman. The new fleet will also be leased to a private-sector operator to manage, operate, and maintain the facility, while ownership remains with GAM.

Evaluation of the experience to date

The tender for the second phase of Amman Bus has been released. However, the buses have not been purchased, nor deployed yet. Therefore an evaluation limited to the experience so far is discussed herein.

Amman Bus acts as a vehicle for future investments that benefit the greater public. The installation and use of high-tech systems that operate the bus and guide passengers contribute to the accuracy and efficiency of performance, creating a quality service. The introduction of 15 electric buses in the second phase of the project further encourages the transition to EVs and broadens the application of technology and efficiency across the country. Amman Bus is considered a step in the right direction – high quality buses with tracking systems connected to a mobile application for a better user experience. What makes the business model even more useful is that it does not depend on the number of passengers, but on the *distance* traveled, which enhances the service quality for users. Further information about the business model is discussed in section **Error! Reference source not found.**.

The 15 electric buses, as part of the second phase, are to operate on routes with easy terrain. This pilot phase will test the transition towards e-buses on a wider scale by demonstrating the reliability of this technology to operate in Amman topography, weather and with its user demand patterns, all necessary to build trust in electric buses.

Lessons learned

- Some government officials are still not fully convinced with the reliability of e-buses to operate in Amman's hilly topography with all systems on, including air conditioning. So gradual pilot project implementation is necessary.
- Piloting 15 e-buses represents a considerable opportunity to showcase the feasibility and reliability of e-buses in Jordan, particularly for mitigating range and battery concerns.
- It is notable that multilateral developmental banks are shifting away from financing diesel buses. This international trend can be leveraged in the coming phases of development of transport services. Notably, EBRD will no longer fund diesel buses after this project, while enabling facilities such as leasing schemes and improved business models to cater to this low-carbon shift will likely be developed in the coming years.

4.8 Case Study: Aramex

This section discusses Aramex's initiative in deploying e-vans in Jordan. This case has been included in this report due to similar elements common with bus systems despite being of a different sub-category.

Background

Aramex is a logistics, courier and package delivery company that is based in Dubai, UAE. Jordan is one of its countries of operation. In 2017, the company introduced e-vans and aimed to expand its fleet, as part of an overall commitment to improving the sustainability of its operations. The company also adopts diverse initiatives regarding e-mobility and aims to expand in the region and across the world. The current plan is to expand their *global* e-fleet to 2,000 EVs.

Project Description

At this stage, Aramex operates 10 BYD e-vans in Amman. Each e-van costs around JOD 28,000 (USD 39,500), and the running cost over the course of 3 years is approximately JOD 350 (USD 493) per bus. Aramex reportedly meets 85 percent of its power needs through solar energy. Furthermore, Aramex uses private BYD AC chargers (level 2) that are for the dedicated use of their e-vans. These are installed at their company location, where each charger costs approximately USD 3,000.

While Aramex are pioneers in importing e-vans, they still encountered various challenges, particularly from insurance companies and the customs department. The uncertainty of insurance companies in granting insurance to Aramex stems from the unfamiliarity with the vehicles deployed. Yet, after negotiations and mutual agreement, Aramex was granted insurance for its fleet.

Given that e-vans are for commercial use, the customs department of Jordan imposed duty on e-vans despite being privately owned. At the time of procurement, the

Aramex operates 10 BYD e-vans in Amman. Each e-van costs around JOD 28,000 (USD 39,500), and the running cost over the course of 3 years is approximately JOD 350 (USD 493) per bus. Aramex reportedly meets 85 percent of its power needs through solar energy. Furthermore, Aramex uses private BYD AC chargers (level 2) that are for the dedicated use of their e-vans.

company was exempted from paying sales taxes, but paid 15 percent for custom duties[130]. According to direct consultation with the Customs Department, e-vans are only subjected to 16 percent sales tax, as of 2021.

The BYD e-vans deployed by Aramex have the following specifications:

- Range: 250 Km
- Battery: 46 kWh
- Warranty: 8 years or 500,000 Km
- Cost of e-van (2017): JOD 28,000 (USD 39,500) (approx. 20% more expensive than conventional vans)
- Cost of charger: USD 3,000
- Running cost of e-van: JOD 350 (USD 493)- over 3 years

Evaluation

Since their installation in 2017, the e-vans run by Aramex are operating with high performance quality without any challenges. Also, Amman's hilly topography has not been an obstacle towards the use of the e-vans. However, the scarcity of charging infrastructure in Amman and across Jordan's governorates is among the key challenges facing Aramex in expanding its fleet. Besides, the instability of governmental regulation, particularly regarding taxes imposed on EVs, is a barrier to further investment.\

Aramex e-vans cost approximately 20 percent higher than conventional vans. However, the low running cost and their fuel-saving advantage reportedly make them more feasible and efficient than fuel-based vans. According to Aramex, each e-van saves approximately USD 4,000-5,000 per year compared to their conventional competitor. Additionally, the warranty provided on the battery (8 years or 500,000km) reduces the risks associated with battery issues, where Aramex agreed with BYD to send back the batteries for recycling if they are to be replaced at any time.

Lessons learned

- Aramex presents a pioneering success story of e-vans operating in Amman with no considerable issues, procured at a time of incentives in place. However, an evaluation of the timing and costs of battery replacement is still uncertain for an adequate evaluation.
- Instability in policies and regulations are key challenges for investing in the market, e.g. uncertain tax regulations.
- The limited availability of charging infrastructure is one of the obstacles facing Aramex and companies interested in introducing or expanding EV fleets, particularly in other governorates.
- The impediments Aramex faced with both insurance companies and Jordan customs are first-experience challenges as this is the first case of e-vans in Jordan. But it also indicates that support such as sales tax exemptions can be granted.

4.9 Case study: PDTRA E-Buses

This section discusses and analyzes the two pilot fully-electric buses deployed in Petra.

Background

PDTRA is an independent financial and administrative authority. It was founded in 2009 to develop the Petra region socially, economically, culturally, and as a tourist destination. Petra is considered a UNESCO World Heritage Site, which makes it a special tourist and archaeological site. By 2019, around 1 million visitors had explored the ancient city of Petra.

Project Description

PDTRA attempts to enhance the transportation system in the region of Petra to improve tourist experience. In 2019, Hyundai offered a grant of two custom-made buses to operate within the archaeological site of the city, in addition to the charging infrastructure. The two Hyundai e-buses have the following specifications:

- Cost: JOD 200,000/bus (~282,000 USD, 2019 – excluding tax and customs)
- Tax: PDTRA were exempted from tax and customs (exception for PDTRA from MoF)
- Range: around 210 Km (manufacturer data: up to 290 km if running at a constant speed of 73 km/h)
- Battery capacity: 256 kWh
- Size: 11 meters (38 seats)
- Charging requirements and frequency in current operational conditions: 45 minutes, twice a day
- Owner and Operator: PDTRA

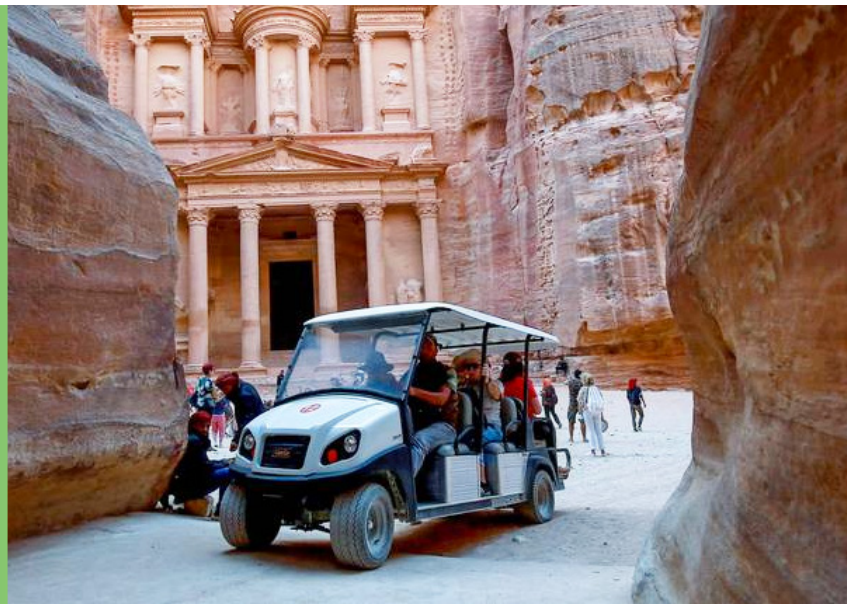
Hyundai also provided PDTRA with 5 charging stations of fast DC chargers (150 kW) and installed them in different locations in the region. Considering the projected route from the Treasury or "Al Khaznah" to the bus station, each bus is charged twice a day, with the battery taking around 45 minutes to be fully charged. The e-buses are projected to operate 15 round trips, each trip being 28 Km along the specified route. This translates into a demand of ~420km/day per bus.

PDTRA emphasizes the importance of zero-emission transport in their strategies, along with deploying solar energy for both charging and other usages in order to preserve the archaeological site[131].

Evaluation

The two buses are operating considerably well, considering the rugged and hilly topography in Petra. According to officials from PDTRA, 20 busses are sufficient to ensure an effective service for tourists in Petra. Also, there are attempts from PDTRA to establish a charging network connected to a solar farm so as to serve EVs in the region.

Petra represents a considerable opportunity in electrifying all public transportation modes, as officials from PDTRA emphasize the importance of electrification in preserving the archeological site.



PDTRA is also testing another electrification initiative that replaces carts, old means of transport with e-cars, while engaging local community. These e-cars are also to transport tourists around different sites in the city.

Lessons learned

- Petra represents a considerable opportunity in electrifying all public transportation modes, as officials from PDTRA emphasize the importance of electrification in preserving the archeological site.
- The two buses in Petra are showcasing the reliability and efficiency of e-buses to build trust in operations and technical viability.
- Financial support remains the main challenge for investment in e-buses.

4.10 Barriers to entry and uptake factors

There are several barriers that hinder the uptake of e-mobility. These are summarized below.

Technical barriers

- For e-buses, the technical barriers are mainly concerns regarding the technology reliability and adequacy to operate in Jordan's hilly topography and hot climate. Specifically, concerns about the range are perceived to be the main issues of the government, and the pilot projects are yet to demonstrate reliability.
- Solution: Close monitoring of projects to date is required, accompanied by city-level planning for public transport charging infrastructure to prepare for scaling up the pilot projects. Additionally, capacity-building for EV maintenance within vocational training centers is recommended.
- For electric cars, the available public charging stations do not keep up with the current demand, leading to concern among owners about the range.

Policy & Legislative barriers

- Instability of governmental regulations regarding taxes on EVs, particularly e-cars, is a big impediment. During the past years, the incentive fluctuations directly impacted importers and retailers.
- The complex and exhaustive demands from EMRC to install charging stations are perceived as a barrier.
- Tax(custom) reduction is only provided for e-cars, while e-buses for public transport are not explicitly included.
- E-buses are subject to 30 percent customs while diesel buses are subject to 15 percent customs.
- E-vans are exempted from customs, but they are still subjected to 16 percent sales tax. While electric micro-mobility vehicles are not included in any tax/custom incentives.
- There are several entities that regulate the transportation sector in Jordan, including MEMR, MoT, LTRC, GAM, and ASEZA. Cooperation and coordination among them is a key challenge but also an opportunity for experience exchange.
- The current regulations impose higher tax in the form of civil responsibility compensation in case of accidents on large companies operating in the public transport sector. This indirectly acts as a challenge for large companies to enter the market, and goes in favor of individual operators or bus owners that account for over 85 percent of operators. In other words, it makes discourages individual operators from merging into larger companies.
- Solutions: It is vital to strengthen the leadership and coordination of the e-mobility agenda in Jordan. This is currently being done by MEMR along with relevant stakeholders. Laws and regulations should be clearly spelt out through this entity, so as to encourage potential investors and buyers. Additionally, stable and adequate incentives for operators, individuals as well as large companies, would also encourage the adoption of EVs in the public transport fleets.

Market and Financial barriers

- Public e-buses are subject to high taxes and customs along with the higher capital cost, paying higher customs duty of 30 percent compared to 15 percent for diesel buses. Therefore, they turn out to be far more expensive than their conventional competitors.
- The current tariff of 37 FLS/kWh (52 cents/kWh) on charging is not sufficient for a profitable business model to invest in fast DC charging stations. This needs to be revisited with EMRC.
- Lack of financial resources is the main challenge for adopting EVs among governmental entities.
- The Ministry of Finance (MoF) is the governmental entity responsible for approving tax and custom exemption or reduction. Jordan's budget relies extensively on taxes, therefore there will be a need to engage MoF on further incentivizing e-mobility.
- Solution: Incentivizing e-buses for public transport plays a significant role in increasing the adoption of e-mobility. Introducing a new, adequate, and remunerative charging tariff is critical to attracting further investments in charging networks. Additionally, emphasizing the socioeconomic benefits associated with e-mobility deployment, along with support from multilateral development banks such as IsDB, WB, EBRD, and AFD would play a key role in urging MoF to support and incentivize e-mobility.

Capacity and Knowledge barriers

- Some government officials and decision makers are skeptical about e-buses and the performance of the technology in the context of Jordan.
- Local maintenance providers do not have adequate knowledge about EVs, which requires capacity-building at the local level.
- Solution: This requires the implementation of awareness-raising campaigns to emphasize the advantages of e-cars and e-buses compared to conventional vehicles, particularly for policymakers. Continuous monitoring and evaluation of ongoing trial/demonstrational projects would also aid the transition to e-mobility. Additionally, introducing vocational training courses on EV maintenance, in coordination with manufacturers, would go a long way in tackling concern about the lack of charging and support infrastructure.

4.11 Summary of situation analysis

Jordan is among the Arab region's leading countries in the introduction of hybrid electric vehicles for light-duty vehicles, but the experience in electric buses has been limited. The cars were initially incentivized by MoEnv through tax and customs exemptions, first on hybrids and then on e-cars. But such incentives that would help promote electric buses are no longer available, although exemptions can be sought on a case-by-case basis. So even though EVs in Jordan today are at a sizeable number – upwards of 24,000 – most of these are e-cars. Electric buses are limited to a few pilot projects to date – 2 electric buses in Petra and 15 proposed electric buses in planned fleet expansions in Amman with the support of the EBRD. This is disappointing as the total number of buses in the country is approaching 30,000 (26,526 in 2019), more than half of which are public buses.

There are however numerous national and sub-national strategies advocating low-carbon transport development. This indicates substantial awareness and intentions, pending support to translate into targeted strategies and action plans of scalable fleet electrification projects. The best available studies indicates the further need to incentivize EVs beyond tax and custom-duties exemptions. This can be attained through means such as climate financing, accompanied with business models that are better tailored to the needs of EVs. Leasing schemes are a prominent solution. This may facilitate the implementation of necessary actions called for in the various national strategies and plans.

Most notably, the Nationally Determined Contributions (NDCs) of Jordan aim to reduce GHG emission by 14 percent – 12.5 percent of which is contingent on international assistance – by 2030. The National Green Growth Plan (NGGP) of the MoEnv includes an action plan for the transport sector that highlights several generic investment opportunities, including potential e-buses, pending further support in planning and implementation. The MEMR is also in its early stages of leading an e-mobility strategy for Jordan and ensuring coordination between the various initiatives.

These initiatives include relevant developments led by GAM through a Green City Action Plan, part of EBRD Green Cities Program, which will be released soon. It includes prospects for e-buses, and a climate action plan. Amman is also among the C40 Resilient Cities initiative, which can be leveraged to enhance capacity-building and experience exchange. Another promising development is the UNIDO project for *Integrated Adoption for Electric Mobility* implemented *with* support from the Global Environment Facility and in collaboration with executing agency, GGGI, and the MoEnv. The Ministry of Transport is also embarking on an assessment of the EV market in Jordan, with a focus on highlighting policy bottlenecks and promoting investments.

This report has reviewed the lessons learnt from various case studies of planning efforts, studies, or actual implementation of pilot projects. Most prominently, two e-buses manufactured by Hyundai have provided valuable experience in proving their efficiency of operation in Petra despite the high CAPEX of about USD 282,000 per bus after full tax and custom duties exemptions. Aramex has also deployed 10 e-vans as part of their fleet since 2017 with satisfactory results, although yet to be further evaluated throughout their lifetime. Officials from both entities confirmed high levels of efficiency, reliability, and adequacy of these EVs in their respective contexts in Jordan. Elsewhere, 15 electric buses are planned to be deployed in a second phase of the Amman Bus project with support by the EBRD, promising to shed more light on context-specific needs of scalable electric bus systems. Studies for electrification elsewhere, specifically for the

BRT projects, Amman and Amman-Zarqa, have been conducted as well, although yet to secure the project with the necessary funding. The latter is also an opportunity to seek relevant technical assistance and climate financing.

Also, the development of regulations and incentives revolving around public transportation, buses in particular, is necessary. It is necessary to further promote investments in the sector and promote the development of startups or novel business lines that will deliver services along the supply chain –battery collection and recycling, partial local manufacturing of components, and so on – to foster local job creation, industrial competitiveness, and link the provided incentives, such as subsidies or tax exemptions, to a return to the local industry.

4.12 Examples of potential projects

This section gives an overview of examples of potential opportunities for e-buses in Jordan for indicative purposes.

Jordan has achieved considerable EV uptake, even though mainly e-cars, in recent years and is continuing to advance the transition towards e-mobility led by the government, MEMR specifically. There is political will to advance bus systems, address increasing motorization and electrification of fleets where possible, but the size and growth of the market is limited compared to other large countries in the MENA region such as Egypt or Morocco. Nevertheless, there are several opportunities for investment in the following areas of interest that can be suggested based on this exploratory study and stakeholder consultations:

- **Amman Bus:** After deployment of the 15-e-buses pilot phase, there will be an opportunity to expand the Amman Bus fleet, potentially with more e-buses integrated with fleet, or comprising the whole fleet. However, some form of a substantial subsidy or incentive would be required.
- **Charging Infrastructure for Buses:** Jordan lacks extensive charging infrastructure for EVs for both cars or buses. The government is studying the potential for developing a stimulating investment environment, particularly for charging infrastructure. Thus, investing in charging networks is expected to be more feasible if the legislative framework in this regard is improved. In the case of bus systems, this would be part of any fleet electrification project planned after concluding the dedicated charging strategies ideal for each context. Local production of components may also be an incentive to align with the national agenda for enhancing local industries and manufacturing capabilities.
- **Electrifying the second phase of the BRT system with 18m trunk buses/12m feeder-buses:** This is a potential idea to be explored with GAM as competences and knowledge-building gradually develop among the competent authorities to deal with novel technologies and associated challenges. Significant steps forward have been taken in cooperation with GGGI as a leading player in this field in Jordan, shedding light on the differences between technologies, and the low rates of return if necessary incentives are not provided.
- **Inner buses for tourist cities:** There is still room for better transportation services between the sites of Petra, Aqaba, and Wadi Rum, also known as the 'Golden triangle'. This is an area where support can be solicited from OEMs – as in the case of Petra with Hyundai's intervention – as a branding or CSR initiative, strengthening the e-mobility momentum in Jordan.

  As an example, Aqaba is an important tourist attraction and a special economic zone with favorable investment laws. Since its population is rapidly growing and the governorate is expanding in the northern region where high demand for public transport is needed, it presents an opportunity for investment in an e-bus system, and an environment conducive to testing novel business models in a small city.

After deployment of the 15-e-buses pilot phase, there will be an opportunity to expand the Amman Bus fleet, potentially with more e-buses integrated with fleet, or comprising the whole fleet. However, some form of a substantial subsidy or incentive would be required.

- **Battery life cycle management:** Untapped potential opportunities exist in life-cycle management for all electric vehicles including electric cars and buses. For this, businesses associated with battery maintenance, reuse, and recycling of battery components must be developed.
- **E-Bus manufacturing:** This is still an untapped sector in Jordan. There is just one bus manufacturer at present, building bodies. This implies a huge potential for growth as demand increases, especially in alignment with the various national and sub-national strategies developed for the transition to public transport modes. Local contribution in the value-chain could help reduce costs of e-buses for the Jordanian market if high roll-out targets are pursued by the government over the long run. In fact, if Jordan adopts a similar approach to that of Egypt, it may help cater to export markets as well eventually.
- **Programs for electrification of private-sector bus fleets**: This is also an untapped opportunity with a diverse range of fleets, including tourism operators, schools, universities, airport shuttles, logistics providers, fast moving goods and beverages companies, and so on. The electrification drive for private bus fleets implies the possibility of partnering with diverse operators. For this, the experience of ARAMEX would be a good lead to follow – particularly with sound feebate schemes that could set limits for regular ICE vehicles, including emission regulations.

Among the investment opportunities identified, the project that is likely to be significantly scalable would be Amman Bus, particularly, after the successful deployment of the second phase of 15 e-buses. Considered a flagship project, it could be expanded to cover different routes and several areas across Amman, as GAM and Amman Vision intend to continue expanding Amman Bus fleet in the coming years. Notably, GAM is preparing its Green City Action Plan (GCAP) with support from EBRD, while multilateral development banks generally move away from supporting conventional ICE buses.

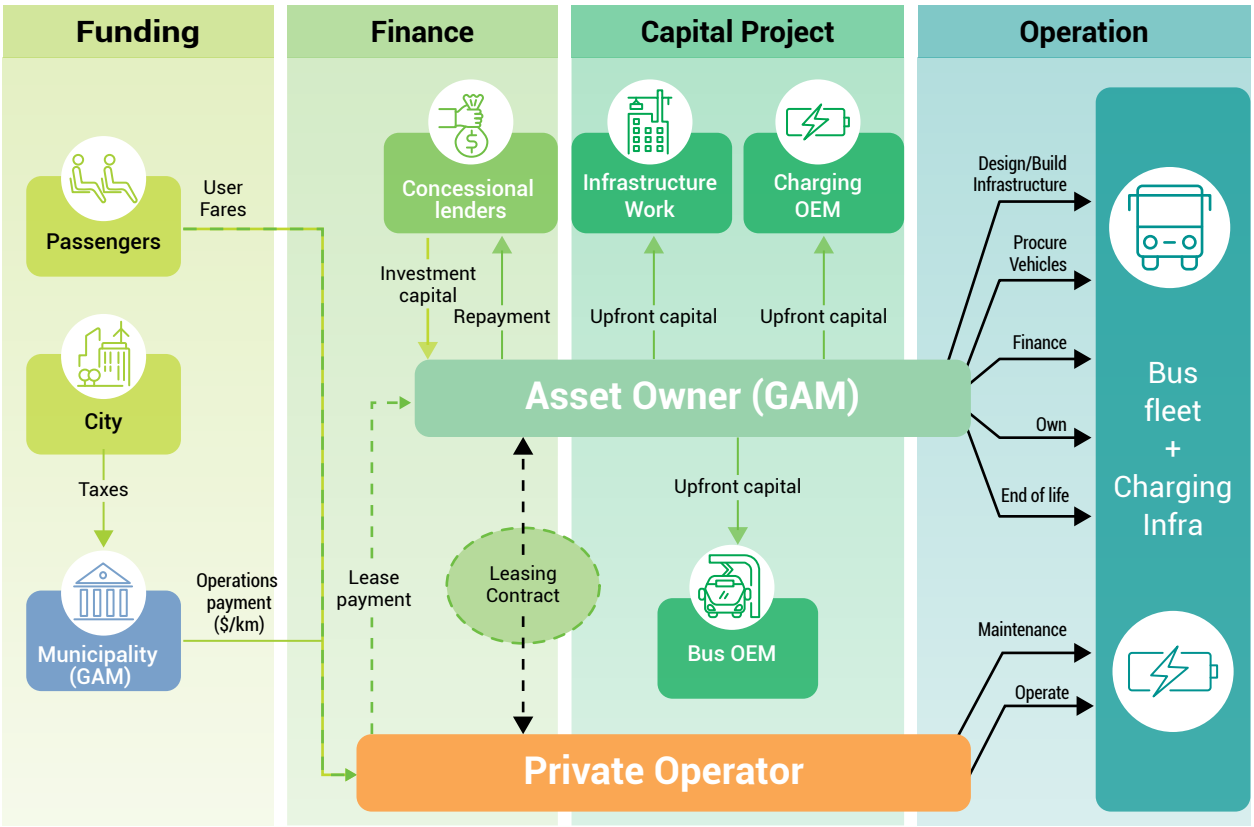
Financing models

Enabling business models are a prerequisite to sustainable and scalable e-mobility deployment. Unbundling asset ownership and operation may play a key role in reducing the high capital cost burden. For instance, Amman Vision is following a financial leasing approach to reduce the risks and share responsibilities for both phase one and the planned phase two of the project. Furthermore, it is leveraging green finance from the EBRD and GCF to contribute to covering the high capital cost.

Their business model entails hiring a private sector entity to operate the fleet, while asset ownership remains with GAM. GAM is responsible for setting the fare, monitoring and evaluation of the transportation service, and imposing fines in case of violation. GAM makes payments to the operator on a per kilometer basis. The figure below further illustrates the business model followed by GAM and AVID.

The financing schemes are expected to be developed further with the UNIDO project, which involves a prospective e-mobility financing facility. Ensuring synergies among various development partners is critical for the advancement of such efforts.

Figure 16: The Business Model Followed in Amman Bus



(template courtesy of Anthony Courreges, C40, adapted by authors)[132]

Develop a specifically targeted strategy for electric buses in public transport as a key area of high-impact intervention. This is yet to be developed within a sustainable mobility master plan (SUMP) for the cities of Jordan. Therefore, a clear vision and clear targets must be set to align efforts of the various authorities and development partners.

4.13 Recommendations for Planners and Development Partners

Key recommendations for policymakers and development partners in Jordan are presented in the following sections, responding to the SUM4ALL categorization of barriers, and specifically noting the key issues relevant to the case of Jordan.

Policy and Legislative Recommendations

- **Develop a specifically targeted strategy** for electric buses in public transport as a key area of high-impact intervention. This is yet to be developed within a sustainable mobility master plan (SUMP) for the cities of Jordan. Therefore, a clear vision and clear targets must be set to align efforts of the various authorities and development partners. There are indeed abundant strategies and plans at both national and subnational levels that already advocate the generic components of low-carbon development and sustainable cities, including transport. They all reinforce discourses aligned with international trends, but have yet to develop a strategy specifically for electrification of the vehicle stock of Jordan, specifically bus fleets.

A dedicated e-bus national strategy with clear intent for market stimulation and clear targets is notably already part of MEMR's priorities under Jordan Energy Strategy and Jordan's reform agenda.

- **Align with ongoing strategies and action plans** such as the studies by MoEnv that are implemented by GGGI (e.g. NGGP/GG-NAPs), JES by MEMR, and the Green Cities Action Plan by GAM with EBRD, already in process. This would lay the foundation for electrification of transport in Amman. Opportunities in other populous cities may follow.
- **Set clear incentives** for e-bus procurement, such as tax and custom duty exemptions.
- **Revise the tariff** for electricity charging. The profit margin should be remunerative for investors. Liberalization of the market can also play a role in attracting investment in charging stations.
- **Plan for vehicle-to-grid** and vehicles as storage systems. This would allow for more synergies between EVs and the grid. EVs could eventually act as a storage system for high RE production, while providing energy back to the grid in peak hours.
- **Develop and adopt reuse and recycling policy** and regulation for EV batteries. This holds potential for investment opportunities in this field, along with the importance of minimizing the environmental risks associated with battery disposal.
- **Consider support for EV and EVSE (Electric Vehicle Service Equipment) manufacturing** in Jordan. This could take the shape of gradual partial local production, for which a stimulating legal environment can be enabled, introducing PPP mechanisms to attract investment to the country similar to the plans advancing in Egypt.
- **Leverage the recent PPP law No. 17/2020**: The Government of Jordan aims to enact the law and create the enabling investment environment needed. This could also be sought in the second phase of the BRT and the expansion of Amman Bus. Additionally, a similar business model to Amman Bus could be replicated in several governorates across Jordan, including Zarqa, Irbid, Madaba, Maan, Karak, and Aqaba.

Capacity and Knowledge Needs

- **Develop tailored information products and 'multichannel' capacity measures** to support city-level strategy development dedicated to e-bus deployment specifically. This should include:
  - Understanding the available technology, taking into consideration the positive environmental effects, along with noise reduction.
  - Understand the TCO of e-buses corresponding to charging strategy scenarios, following a collective approach, and to account for the associated social and environmental benefits of e-buses, providing tailored and relevant rules-of-thumb applicable to the local context.
  - Introduce new leasing mechanisms and PPP models that would foster the adoption of e-buses in public transport, taking Amman Bus as a case study.
  - Draw lessons learnt through monitoring and evaluating the proposed 15 e-buses pilot project of Amman Bus. This holds the potential to shed light on the limitations, challenges, and alternative solutions, particularly regarding efficiency and range. Also, they could be compared with the other Amman Bus diesel buses operating in the same circumstances.
  - Draw on the data and lessons learnt through other e-buses operating in Jordan, such as the two e-buses in Petra and other prospective projects, to ensure locally tailored capacity building material and information products for experience-exchange.
- **Provide locally-tailored training** for consultants, planners, and policy makers on available tools and guidelines for planning for e-mobility projects appraisal development and for electric bus systems specifically for economic and financial evaluation. A relevant example is the GIZ E-bus global tool, which may be further tailored to the local needs.
- **Conduct impact evaluation studies.** With multiple experiences of fleet electrification developing over time, it is necessary to ensure objective evaluation of outcomes, through a third-party for example, to adequately understand the successes and failures or weaknesses over time.
- **Set adequate targets and constraints/regulations for diesel buses.** It is necessary to also set in place clear targets and regulations for diesel buses. This could be in the form of compulsory Euro standards, phase-out plans, and so on, to ensure limiting the competitiveness of ICE vehicles.

Market and Financial Recommendations

- **Mainstream adequate tendering and procurement procedures**. Although procedures are being developed at the level of specific projects, there is yet to be a thorough revision of procedures to cater to all future developments in a manner incentivizing electric buses and facilitating their competitiveness in prospective fleet renewals or expansions.

- **Internalize external costs in project appraisals**. In addition to the common incentives of tax and custom duties exemption that can be granted, it is necessary to also incorporate the non-financial benefits such as health and environmental benefits in plans and project appraisals, or in planning incentive schemes.
- **Leverage available climate finance opportunities**. There is a huge potential that should be tapped into for accessing climate finance, building the necessary institutional capacity, and financing models to cater specifically to EVs and enable scaling up. Several noted opportunities for electrification, prospective BRT fleets for example, present untapped potential in this respect.

Technical RECOMMENDATIONS

- **Improve lifecycle management** of batteries through development of regulations for reuse, recycling and disposal.
- **Plan for land allocation** for the potential establishment of charging stations and depots.
- **Expand charging infrastructure and options** for higher power output or charging techniques. For example, current common 40kw ports imply long charging time and large batteries, which might not be suitable for all contexts.
- **Plan to accommodate/leverage ramp-up demand** over the long run for adequate grid-integration and management. This would help mitigate potential adverse grid impacts, and to benefit from Vehicle-to-Grid and Vehicle-to-Everything solutions to enhance grid flexibility and storage capacity over time.
- **Support and promote availability of micromobility options** to tackle last-mile challenges, especially in cities of hilly topographies. E-scooters, e-bikes and electric three-wheelers, including utility vehicles like the pedal-assist cargo bikes, present a scalable opportunity if the enabling incentives are in place.

SECTION

05

MOROCCO

Morocco is a constitutional monarchy located in the northwest of Africa on the coast of the Atlantic and the Mediterranean with a population of 36 million[133]. Its capital is Rabat and the economic capital, Casablanca.


DabaPay
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Morocco is the fifth-largest economic power in Africa, clocking an average annual GDP growth rate of 3.2 percent[134] during the period 2013-2019. Its economy grew at 3.4 percent in 2019. Diesel and gasoline consumption have been growing at similar rates – 3.6 percent and 3.8 percent respectively in 2016.

5.1 Overview of transportation sector

The importance of the transport sector in Morocco can be appreciated by the contribution it makes to economic growth and employment generation as noted in the following highlights[135]:

- It represents 6 percent of the GDP and 9 percent of the added value of the tertiary sector.
- It employs 10 percent of the urban working population.
- The revenue from the sector contributes 15 percent to the General State Budget.

The transport accounts for 38 percent of the country's final energy consumption. It accounts for 16 percent of total emissions and 28 percent of the energy module's emissions. With continued growth and rising motorization rate, the country expects a growth of energy consumption and emissions of up to 350 percent by 2040.[136]

Table 16: Final energy consumption in Morocco by sector[137]

Sector	1990	%	2000	%	2010	%	2015	2018	%	Increase 1990/2018
Industry	1,96	34,7	2,22	26	2,91	22	3,1	3,31	20,3	+69 %
Transport	1,3	23	2,68	31,4	4,45	33,7	5,2	5,97	36,6	**+359 %**
Residential	1,28	22,7	2,1	24,6	3,31	25	3,79	4,05	24,9	+216 %
Tertiary	0,63	11,2	0,77	9	1,12	8,5	1,22	1,3	8,0	+104 %
Agriculture	0,27	4,7	0,48	5,6	0,89	6,7	1,11	1,22	7,5	+358 %
Non-energy uses	0,21	3,6	0,29	3,4	0,53	4	0,52	0,44	2,7	+115 %
Total	5,65	100	8,54	100	13,22	100	14,95	16,29	100	+188 %

It should be noted that the transport sector, except airplanes, mainly uses gasoline and diesel.

More than 86 percent of fuel used by transport, excluding aviation is diesel, while gasoline represents only 12 percent consumption. Prevalence of low-sulphur diesel is a noted advantage in the country. Morocco is among the earliest countries in the Middle East and North Africa region to adopt cleaner fuels.

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Table 17: Development of gasoline and diesel consumption through 2015-2016 ('000 tons)(Ministry of Energy and Minerals)[831]

Subject	2010	2011	2012	2013	2014	2015	2016	Rate of growth
Gasoline	549	565	569	554	540	608	672	3,60%
Diesel	4 543	4 830	4 903	5 098	5 197	5 479	5 666	3,80%
Total	5 092	5 395	5 472	5 652	5 737	6 087	6 338	3,70%

Fuel and Electricity

Diesel and gasoline prices are associated with fluctuations of international prices. During the period 2015-2017, the selling price of diesel ranged between 7.45 and 9.68 dirhams (USD 0.83 to 1.25), while for gasoline, it ranged between 9.24 and 11.16 dirhams (USD 1 to 1.25 USD) at the pump.

The price of electricity in the country differs according to use and customers. At this early stage of development, Electric Vehicles of different types can access electricity[139] at varying rates. The following summary indicates the different segments:

- Home use and private lighting: Ranging from 0.9-1.6 DH/kWh (0.1 to 0.18 USD/kwh) corresponding to 6 segments within the range of 0 to > 500kWh.
- Medium voltage electrical energy tariffs for 'professional' use: A fixed premium of 512.6 DH/kVA (57 USD/kVA), plus prices ranging from 0.74 DH/kWh—1.426 DH/kWh (0.08-0.16 USD) attributed to predicted times of off-peak hours and rush hours.
- Low voltage tariff for driving force, industrial, and agricultural use: Ranging from 1.364-1.676 DH/kWh (0.15-0.19 USD/kWh) corresponding to 3 segments within the range of 0 to >500 kWh.

5.2 Traffic and Vehicles

Since 2008, road traffic has increased overall by 62 percent. It is increasing on the national road and motorway network (+ 57 percent), on regional roads (+ 48 percent) and on provincial roads (+ 105 percent)[140].

Table 18: Vehicle kilometers per day in Morocco

Veh. km/day	2008	2010	2012	2014	2016	2018	CAGR
National roads & Highways	4262	509	5952	602	6373	6683	4.6%
Regional roads	1395	1507	1619	1742	1922	2067	4.0%
Provincial roads	944	112	1271	1524	1639	1935	7.4%
Total	6601	7718	8842	9285	9935	10685	4.9%

Source Ministère de Transport

There are 4.3 million vehicles in Morocco according to latest data by the statistics agency in 2018[141]. The greatest concentrations are in Casablanca and Rabat regions. With a growth of 5 percent per year, and more than a third of vehicles still more than 20 years old, meeting sustainability targets is a challenge, and the move toward collective transport is imperative. Further details of the vehicle stock and available data on buses are presented in section 5.8.

5.3 Electric vehicles

The electric car market in Morocco remains in early stages and difficult to monitor due to limited dedicated monitoring of EV penetration. Highlights of available information are as follows:

- There are 15 Electric Trolley buses and 5,064 ICE buses in Morocco. The first experience of launching e-buses in Marrakech was on the occasion of COP22.
- Four double-decker electric buses[142] are available for tourism purpose.
- In 2018, 93 full-electric cars were listed on the market, constituting 0.02 percent of the car fleet in Morocco. In the rental car category, 1,000 full hybrid vehicles (mainly cars) are registered as compared to140,000 conventional [143] vehicles.
- Under the micromobility vehicle category, about1,000 electric mopeds are listed as compared to 900,000 thermal vehicles.

5.4 Management of the municipal network

Economic growth has not only allowed urbanization to gain momentum but also to boost the level of household consumption, thanks to the ease of payment and the ownership of cars, giving more and more the opportunity to travel in urban areas and further extending distances.

Morocco has started to direct its efforts towards integrated approaches for transportation. But, the current status

Public transport in Morocco is predominantly provided by bus. The country added the tramway to Casablanca and Rabat-Salé 10 years ago. However, the management of the tram is the responsibility of public limited companies and not linked directly to the municipalities, although they are associated with the board of directors of these companies.

remains insufficient in the absence of an institutional framework for promoting enhanced management of sustainable urban mobility.

Public transport services

Public transport in Morocco is predominantly provided by bus. The country added the tramway to Casablanca and Rabat-Salé 10 years ago. However, the management of the tram is the responsibility of public limited companies and not linked directly to the municipalities, although they are associated with the board of directors of these companies.

Public transport in towns has long suffered from irregularity in service, lack of comfort and safety, and dilapidated state of vehicles. Unfortunately, the country's public transportion has suffered from bad publicity and conveyed an image associated with lower social status rather than with sustainability.

The bus transport system has failed to keep up with the constant needs for mobility, especially in the outskirts, due to the poor coverage of urban areas and unsatisfactory quality of service. This situation is accompanied by serious financial difficulties for operators due to sub-optimal planning of routes, operation and finances, whether they are regulated or licensed, Moroccan or foreign. The commissioning of the first mass transport in the Kingdom – tram operation in Rabat, Salé and Casablanca – although successful, is not enough as far as public transportation is concerned.

Urban challenges in Morocco

Moroccan cities face multiple challenges that are reflected in a vicious circle of urban growth, urban sprawl, and economic and social changes driving a dramatic increase in the demand for urban travel.

With an estimated urbanization rate of close to 60 percent[144], Morocco continues to record sustained urban growth that has spiralled into haphazard urbanization and a dispersion of socio-economic activities. This results in longer travel distances and increased needs for motorized mobility.

The Kingdom is also experiencing a phase of steady economic growth which, thanks to access to credit, is linked to increase in household car ownership – 27 percent of households own a car. However, the motorization rate is still low and walking remains the dominant mode of mobility in Morocco, accounting for more than half (54 percent) of urban trips[145]. The demand for individual mobility is also increasing due to the greater participation of women in the work force.

In large agglomerations, traffic is made particularly difficult by the increase in automobile traffic – private vehicles and taxis – and blame is often directed towards the limited road network and the weaknesses in traffic and parking management.

The stock of bus transport fails to meet mobility needs, especially in the outskirts, leading to poor coverage of urban areas and unsatisfactory quality of service. The management of urban transport is going through difficult times due to a host of reasons – the virtual bankruptcy of the public authorities, concessionaire operations stacked only along the most profitable lines, delegated management, the increase in supply of large taxis, and the rise of informal transport. The result is a crisis-ridden public transportation, which continues to suffer despite the entry into service of the first mass transport in the Kingdom in addition to the projects of BRT in Marrakech and BHNS in Agadir.

Despite some of the big cities undertaking in recent years local transport plans (Urban Mobility Plan), the modal split of trips is still skewed towards walking. This can be reasonably valid for the other medium-sized cities of the Kingdom as well.

Networks in the city

Towns and cities in Morocco have made small changes to lines, stops and routes, often following complaints from citizens. More recently, there has been restructuring of the networks following targeted studies, as in the case in Agadir, Casablanca and Rabat. The current approach is to create shorter lines and interchange points between bus lines and with trams, the objective being to increase the connectivity of the network and the reliability of the service in terms of frequencies.

In the case of Casablanca and Rabat, the restructuring follows the commissioning of the tram lines and is largely driven by complementary aspects so as to promote intermodal travel. However, this intermodality is limited to buses and trams; in Rabat the tram does not accept bicycles, for example[146].

State of public transport of major cities in 2018 indicating bus and tram lines in each city.

Table 19: Bus and tram lines in cities of Morocco*

Agglomeration	Networks		Lines	Evolutions	Structure
Agadir	Bus	Urban with peri-urban lines	37 = 22U + 15P	Network restructured in 2012, significant increase in demand and consequent purchase of buses	Rather meshed in the center of the city with radial peripheral lines
Casablanca	Bus	Urban	70	Recently finalized restructuring study	Rather meshed with long lines
	Tram	Urban	5	Ongoing	East-West line divided at the center into two branches
Fes	Bus	Urban with peri-urban lines	53	Line lengthening	Radial, centered on the city center and on the city center-medina axis with parts of the line acting as a bypass
Marrakech	Bus	Urban	21	Creation / extension of lines	Radial and concentrated on a few axes
	Bus	peri-urban	17	Line extension	Radial
Rabat-Salé-Temara	Bus	Urban with peri-urban lines	55	Restructuring study in progress	Radial with few correspondence points
	Tram	Urban	2	Extension of lines in progress and relay parking in progress finalization	Lines which cross by a common section near the bridge between Rabat and Salé. Témara not served.
Tanger	Bus	Urban with peri-urban lines	43 = 26U +17P	Newly created network with the new delegated management	Rather meshed
Tetouan	Bus	2 = Urban & peri-urban	38 = 18U+20P	Recent modifications to routes and terminus have been approved (amendment to the contract)	Urban network concentrated on the axis of the valley

* U = Urban line, P = Peri-urban line.
Source : Données fournies par les opérateurs et entretiens.

In urban areas, discussions and projects are underway. There is some focus on maintaining good commercial speed in the face of increasingly difficult traffic conditions with increasing traffic. Casablanca and Rabat where the pioneers in developing tram lines while the move towards BRT systems and expansions is also in progress.

Improvement in operations and fleet management systems is also in progress in some cities. Operators are setting up an operating assistance system (SAE) that will allow them to geo-locate their fleet, better manage irregularities, and make journey times more reliable while providing travelers with relevant information on waiting time at stops. Public bus transport company, City Bus Fez, recently undertook these measures, and now another company, Alsa Tanger, is planning to do the same.

Fare prices are subsidized and provided as indicated in the table below. The prices are low compared to international prices but found suitable to the socio-economic status prevalent in Morocco, with prices in Marrakech, for example, of 4-18 DH (0.45-2.0 USD). Further packages such as those for students (subsidized monthly tickets) are also available for certain groups.

Table 20: Public transport prices in the main cities (DH)

Agglomeration	Type of pricing			Unit prices (min-max, in DH)
Agadir	Bus	U	Single price	3-4
		P	Per line	4-9
Casablanca	Bus		Per line	57 lines : 4 4 lines : 4,50 2 lines : 6
	Tram		Single price on rechargeable media	6 (+1 for rechargeable support 10 trips OR +15 unlimited)
Fès	Bus		By line and distance	2.50 - 7.50 (50% lines at 3.50)
Marrakech	Bus	U	Single price	4
		P	By line and distance (4 zones)	4.50 - 18
Rabat-Salé-Témara	Bus		Single price	4
	Tram		Single price on unitary support	6
Tanger	Bus	U	Single price	3.5
		I	By line and according to distance	3.5 - 8
Tétouan	Bus	U	Single price	NA
		I	By line	NA

The discourse on improving public transport is adversarial to large taxis and advocates relegating these to the outskirts of the city which, by law, is where they belong. This has caused substantial opposition from the more expensive taxis, delaying the work on public transportation system:

- In 2012, on the first day of operation of a shuttle between the airport and the center for collective transport, the large taxis formed a barricade which prevented the shuttle from passing and resulted in ending the shuttle services. The shuttle cost 40 DH for a traveler compared to 300 DH for a grand taxi.
- In 2013, when the tram services started, large taxis again went on strike, but in the medium term, only abandoned the road served by the tram. The success of the tram can also be linked to a loss of the customer base of large taxis, since demand for the Medina Bus has not significantly changed.

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5.5 National and Subnational Strategies and Plans

There is not yet a dedicated national strategy for e-mobility in Morocco. However, several plans and strategies are in place to include e-mobility and/or enabling conditions and guidance as part of plans and strategies of wider scope. City-level plans are also in place, indicating Morocco's relative advanced position with regards to decentralized planning for sustainable mobility in comparison with other countries in the MENA region.

National Strategy for Urban Mobility

The development of Morocco's national strategy on urban mobility, was conducted with the support of international institutions through the following steps[147]:

- Holding of the First National Meeting of Local Authorities (2006 in Agadir) on development of cities, dealing with local public services with a focus on urban transport issues;
- Organization of several thematic meetings relating to the urban mobility;
- Organization of the 1st Regional Seminar on Urban mobility in Mediterranean (January 2008 in Skhirate) under the theme "Quality of life and competitiveness of cities: a challenge for public authorities"

To achieve the objectives of the National Strategy on Urban Mobility, four areas of intervention have been followed:

(1) Urban Mobility Plans

Urban Travel/Mobility Plans (UMP) have been made mandatory in all major cities. They were initially only recommendations, but were later mandated to receive funding for transport projects. Multiple cities have received support to develop the UMPs further into « Sustainable » mobility plans (SUMPs) with the technical support provided by the project "Mobillize Your City"[148].

These documents are essential tools for the control of problems linked to mobility and the satisfaction of transport in optimal conditions of quality and cost.

(2) Strengthening the institutional, legislative and regulatory framework

This area of intervention is about giving local authorities the capacity to define and implement a coherent strategy in terms of planning, organization, and management of public transport.

To do this, the establishment of an institutional, legislative and regulatory framework is necessary, through the drafting of a law on urban travel and the establishment of transport organizing authorities in large cities. The objective is the definition of urban travel parameters for the identification of local actors involved in the development of PDUs, and the definition of urban public transport services.

(3) Capacity-building of communities:

With regards to the organization and management of the public transport service, priority should be given to public transport, the only mode capable of guaranteeing better accessibility to citizens while preserving the quality of the environment and the living environment by means of:

- The development of public transport through structured bus networks that are complementary to other modes;
- Improving public-private partnerships for professional service management;
- The promotion of investment and the modernization of transport modes.

To achieve these objectives, building the capacity of local authorities in urban transport project management is necessary for efficient organization and management of the public transport service, and guaranteeing quality service at the lowest cost.

In terms of traffic and road management

Effective management of traffic and roads inevitably involves the implementation of the following actions:

- The development of effective traffic plans with network prioritization, optimization of traffic flows, modern regulation of traffic lights, and appropriate arrangements, particularly favoring the traffic conditions of buses and pedestrians;
- The definition of an effective parking policy;
- Improving the efficiency of the traffic police.

Capacity building of management units where they exist, or the creation of other competent and efficient units for the management of traffic, roads and parking in large cities, will undoubtedly help implement the aforementioned actions. Equitable road network between the different modes of travel and better regulation of traffic are the other prerequisites.

(4) The establishment of sustainable financing mechanisms

Given the importance of the investments required to make up for the cumulative delays in meeting the demand for a capacity public transport system, it is necessary to develop sustainable financing mechanisms.

To do this, the following measures are recommended:

- Mobilization of sustainable funds to finance infrastructure and develop public transport;
- Contribution to the renewal of the fleet;
- Establishment of a framework favorable to public-private partnerships allowing in particular the compensation of operators for service rendered to certain user categories.

The national urban transport strategy has taken several stages for putting in place mechanisms for the organization, planning, and financing of the sector, and for strengthening the sector's capacities to meet the needs of citizens.

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A slew of measures have been taken by the Ministry of the Interior through the General Directorate of Local Authorities, in collaboration with partners. These include in particular:

- Technical and financial support-to-support local authorities and particularly large cities in developing and implementing their urban travel plans;
- Support for local actors in the city of Casablanca to create an organizing authority for urban travel in the Casablanca region, through an agreement between the local communities concerned and the local authorities;
- Support for the city of Casablanca for the launch and monitoring of the various stages of the tramway project;
- Support for the Rabat and Salé tramway project;
- Strengthening the capacities of local authorities in urban travel in collaboration with the Hassania School of Public Works.

As part of the World Bank support for the national strategy of urban development signed by Morocco in 2011, the Kingdom got a loan of € 100 million. This falls within the framework of a series of development policy loans.

This amount is the first installment of three, intended to implement government strategies in several sectors, including urban planning and sanitation.

National Strategy for Sustainable Development (NSSD)

In 2017, Morocco adopted a National Strategy for Sustainable Development by 2030. This was drawn up by the Ministry of Energy, Mines and Sustainable Development, which incorporates among others the following strategic axes:

- Make the exemplary nature of the State a lever for the implementation of sustainable development. At this level, the renewal of the state's car fleet with electric and hybrid vehicles is one of the first measures that the government intends to put in place. Clean cars should thus constitute 30 percent of the fleet by 2021. This measure will generate energy savings, based on which the government aims to achieve 15 percent reduction in fuel consumption in 2021.
- Speed up the implementation of energy efficiency and transition policies.
- Promote sustainable mobility.

Regarding the axis of promoting sustainable mobility, the NSSD indicates that the optimization of existing networks is crucial as is the improvement of exchange platforms allowing efficient transfers between the different modes of transport. For individuals, it must adapt to each mobility need, in particular by offering a multimodal offer. These clean transport development initiatives, which also present the opportunity to promote sustainable transport among tourism operators and manufacturers, and to develop jobs linked to energy efficiency, must be continued and rationalized.

Main issues arising from the diagnosis are:

- Economic:
- Reduce the consumption and energy intensity of the transport sector.
- Strengthen the fight against the informal sector.
- Reduce transport costs by implementing the national logistics competitiveness strategy (-5% of GDP).
- Social:
- Improve access to public transport in urban blocks and slums.
- Improve road safety and the quality of vulnerable road networks.
- Environmental:
- Encourage clean modes of transport in the city.
- Encourage savings and the reduction-at-source of exhaust gas emissions to the environment.
- Governance:
- Take into account the development of rural and urban areas (new towns) as well as the development of industrial and economic activity zones in transport planning.
- Systematize and accelerate UMPs.

The NSSD accordingly sets 4 goals:

- Goal 55: Improve energy efficiency in the transport sector and promote clean transport
- Goal 56: Accelerate the transport fleet renewal program
- Goal 57: Accelerate the implementation of the national strategy for the development of logistics competitiveness
- Goal 58: Promote and develop multimodal transport in Morocco

Roadmap for Sustainable Mobility in Morocco

In 2018, a roadmap for Sustainable Mobility in Morocco was drawn up by the Ministry of Transport with the support of GIZ and the Energy and Engineering Company, SIE. It aims to bring out a common vision of mobility of people and goods, one that gives access to economic and social opportunities, is off ordable, efficient and energy-saving, but is also low in emissions and considerate of the environment and the population. It is a participatory process that brings together the mobility actors — state and private — and the different sectors within transport, energy and cities. To respond to the planning and investment cycles of mobility, the Roadmap targets a long-term vision – beyond 2050. The objective is to orient public and private decisions towards sustainable mobility.

Morocco's Roadmap for Sustainable Mobility aims to support the Kingdom's national strategies and its ambition to create a new model of development with high added value and shared prosperity. The overview of strategies presented below is not exhaustive but aims to give a sense of the many strategic objectives related to the evolution of transport and sustainable mobility. Special attention is given to the National Strategy for Sustainable Development.

Components of the Global Macro-Roadmap of PPMC are:

- Integrated urban transformation
- Low carbon energy
- Optimization the efficiency of modes and systems
- Join up and shorten supply chains
- Reduce unnecessary travel
- Solutions adapted to the rural world
- Construction and adaptation of infrastructure
- Regulatory and financial tools
- Road safety

Among the propositions that have a relation with e-mobility, we find:

- Developing an electric mobility ecosystem
- Promoting the adoption of electric mobility
- Making modes and transport systems with low energy consumption and emissions a lever of competitiveness of the country
- Promoting alternative modes available in Morocco

That is not all. Under the framework of the Paris agreement, Morocco has committed to a reduction in greenhouse gas emissions of 42 percent by 2030, corresponding to a cumulative reduction of 533 Mt of CO2, of which 9.5 percent is in the transport sector.

Nationally Determined Contribution (NDC) 2030 adopted in 2016

- Reduce total greenhouse gas emissions unconditionally by 17 percent, or as much as 42 percent predicated on certain conditions in comparison with the business-as-usual scenario. This corresponds to a cumulative reduction of 523 Mt of CO2[149].
- Achieve 9.5 percent (50 Mt CO2) of cumulative reductions in the transport sector.

Energy Efficiency Strategy 2030

- Reduce transportation energy consumption by 35 percent by 2030[150].
- In addition, aim to achieve more than 52 percent of the Kingdom's energy mix from renewable energies.

Energy Strategy 2030

- By 2030, generate about 52 percent of the electricity consumption from renewable energy and another 25 percent from natural gas. Morocco has a total installed capacity of 25 GW at present. The aim is to reduce the dependence on imported fossil fuels[151].

Transportation Infrastructure Investment Program

- Invest 660 billion Dirhams (€60 billion) by 2035 to strengthen the road network, highway, rail, port, airport, and logistics[152].

National Adaptation Plan (under development)

- Identify climate information, the impacts of climate changes, vulnerabilities for better management of present and future climate risks.
- Integrate the adaptation in planning and sectoral and territorial budgeting. Build capacity for integrating adaptation in development, planning and regulatory processes.

Industrial Acceleration Plan 2020

- Encourage foreign, direct and domestic investments.
- Support the competitiveness of the national economy.
- Position Morocco as a hub between Africa, Europe, America and the Middle East[153].

5.6 Legal and regulatory framework for Bus fleets and systems

Planning in Morocco is characterized by substantial decentralization, as urban transport is planned and developed by municipal authorities.

Historically, Morocco has gone through several stages: first, the creation of public utilities in the 1970s, then the opening up to the private sector in order to overcome the shortcomings experienced by the authorities in Rabat and Casablanca in the mid-1980s. In 2006, law 54-04 on the delegated management of public services set the framework for the area.

Thus, contracts established before 2006 are line concessions (eg Marrakech) while contracts signed subsequently must be delegated network management (monopoly).

In 2014, there was a transformational shift in strengthening the regulatory framework for public transport through Public Private Partnerships (PPPs). The concept was successfully applied to advance transport projects, such as the expansion of the tramway systems and developing the BRT. Act No. 86-12 was promulgated and subsequently updated to allow legal entities created by local authorities, as well as national entities, to engage in PPPs[154].

Existing laws and regulations by category, including specifications provided for certain cases as a softer method for regulation, are as follows:

Urban transport in Morocco and mandates of Local Authorities

- Decree of September 29, 1964: Territorial Collectivities were authorized to create autonomous boards for the management of the urban public transport service.
- Organic Law 113-14 of 5 July, 2015 relating to municipalities gave to local assemblies the competence to create local public services, in particular urban public transport, and to decide on their management methods. Article 83 relating to municipalities gives the municipality the competence to create and manage public services and equipment such as urban public transport, traffic, and signage in public roads.
- Law No. 79-00 of October 3, 2002 relating to the organization of prefectural communities and provinces gave the prefectural or provincial assemblies the power to decide on the creation and management of the intercommunal urban public transport service.
- Law 17-08 of February 18, 2009, modifying and supplementing the 2002 municipal charter, provides for improvement of service management mechanisms through groups agglomerations and Local Development Companies.

Historically, Morocco has gone through several stages: first, the creation of public utilities in the 1970s, then the opening up to the private sector in order to overcome the shortcomings experienced by the authorities in Rabat and Casablanca in the mid1980-s. In 2006, law 04-54 on the delegated management of public services set the framework for the area.

- Law n ° 54-05 of March 16, 2006 relating to delegated management, constitutes the principle that encompasses all forms of outsourced management of a public service or the development of public works.

Land transport for passengers

- Law 16-99 modifying and supplementing the dahir n ° 1.63.260 of November 12, 1963 relating to the transport by motor vehicles on road.
- Dahir (King's Decree) n ° 1.63.260 of 24 Joumada II 1383 (November 12, 1963) relating to road transport by motor vehicles, as amended and supplemented.
- Decree n ° 2-63-364 of 17 Rejeb 1383 (December 4, 1963) relating to the approval of contractors of public transport services by motor vehicles and the authorization of vehicles assigned to such transport as amended and completed.
- Decree n ° 2-63-363 of 17 Rejeb 1383 (4 December 1963) relating to the Coordination of rail and road transport.
- Order of the Minister of Transport n ° 2445-96 of 20 Rejeb 1417 (December 2, 1996) fixing the maximum tariffs for passenger and courier transport by coach.

Staff Transportation and School Transportation

- Specifications relating to personnel transport for others;
- Specifications relating to school transport for others;

Entrepreneur approvals

- Royal Decree No. 246-65 (August 4, 1967) relating to the approval of contractors of public transport services by motor vehicles and the authorization of vehicles used for such transport
- Decree n ° 2-63-364 of 17 Rejeb 1383 (4 December 1963) relating to the approval of contractors of public transport services by motor vehicles and the authorization of vehicles used for such transport.
- Decree n ° 2-83-704 of 7 joumada I 1405 (January 29, 1985) amending and supplementing decree n ° 2-63.364
- Passenger bus station orders

Transport coordination

- Decree n ° 2-63-363 of 17 Rejeb 1383 (4 December 1963) relating to the coordination of rail and road transport.

National Society of Transport and Logistics (Ex Office National des Transports)

- Dahir n ° 1-05-59 of 20 chaoual 1426 (23 November 2005) promulgating law n ° 25-02 relating to the creation of the National Society of Transport and Logistics and the dissolution of the National Office transports. [Official bulletin n ° 5374 of 28 chaoual 1426 (December 1, 2005)]

Tax and pricing

- Order of the Minister of Transport n ° 2445-96 of 20 Rejeb 1417 (2 December 1996) fixing the maximum tariffs for passenger and courier transport by coach.

Legal framework for electric vehicles

Currently, Morocco does not have a regulatory framework to enable the development of the electric vehicle market. However until a more strategic plan is developed in the future, ad hoc interventions as follows have been noted:

- State's exemplary lead-by-example approach in procurement of EVs for government vehicles
- Strong encouragement for 10 percent of procurements of public-owned vehicles to be of EVs
- Deployment of the charging infrastructure for light duty vehicles with a roaming platform and for pilot electric buses.

5.7 Stakeholder assessment

Public Actors and Regulators

Ministry of Energy, Mines and Environment

The Ministry of Energy, Mines and Environment develops and implements government policy in the areas of energy, mining, and geology. This includes taking measures necessary to guarantee the security of energy supplies and improve the access of rural and urban populations to commercial energy services. The ministry oversaw the development of two strategies:

- Definition and implementation of the 2030 efficiency strategy
- Definition and implementation of the National Strategy for Sustainable Development by 2030, established in 2017

Ministry of infrastructure, transport, logistics and water

The Ministry of Equipment, Transport, Logistics and Water (Department of Equipment, Transport and Logistics) develops and implements, within the framework of the laws and regulations in effect, the government policy for road, port, rail and maritime transport. It is also responsible for defining government policy on road safety and coordinating its implementation. The Ministry also oversaw the realization of Roadmap for Sustainable Mobility in Morocco with the support of GIZ and SIE.

Ministry of Industry, Investment, Trade and Digital Economy

The mandates of the Ministry of Industry, Investment, Trade and Digital Economy include the following for the sectors of industry, commerce, and new technologies:

- Develop, validate and implement development strategies;

Concession and delegated management, which are forms of public-private partnerships that provide for contracts between a public authority and a private company. Bus companies such as ALSA, CityBus, TransDev, RATP Dev, are examples of private players that have been delegated services.

- Produce statistics and carry out studies;
- Ensure strategic monitoring and evaluation of the strategies in the said sectors;
- Promote and develop innovation in the fields of industry and new technologies;
- Define the legislative and organizational framework;
- Make proposals for the regulation of the three sectors.

With respect to e-mobility, a study is in progress on the regulation of sustainable transport and on charging standards and infrastructures.

Ministry of Interior – General Directorate for Local authorities (DGCL)

The General Directorate of Territorial Communities has set itself the task of providing legal, technical and financial support to local authorities in the exercise of their powers and providing the necessary assistance for the development of their human and technical capacities.

Municipalities

Article 83 of Organic Law 113-14 empowers the municipalities to create and manage public services and equipment such as urban public transport, in addition to traffic and signage on public roads. They can delegate this power through the following means:

- Concession and delegated management, which are forms of public-private partnerships that provide for contracts between a public authority and a private company. Bus companies such as ALSA, CityBus, TransDev, RATP Dev, are examples of private players that have been delegated services.
- The creation of a Local Development Agency comprised of companies under private law, whose municipalities participate in their capitals alone, or in association with one or more legal persons of public or private law.

These companies are created to carry out economic activities falling within the competence of the municipality. This includes urban transport[155].

Public institution for-municipal cooperation (ECI)

Organizations can be set up for initiatives between municipalities linked territorially as "inter-municipal cooperation establishments" with legal personality and financial autonomy. It can perform several missions including public transport and the development of the travel plan for the municipalities concerned[156].

MASEN (Moroccan Agency for Sustainable Energy)

MASEN's missions are divided into three areas:

- The integrated development of renewable energy installations at the highest international standards
- A contribution to the emergence of a national expertise in the field of renewable energy
- The support of the local areas Masen operates in, following a sustainable model involving economic, human and environmental criteria.

Moroccan Agency for Energy Efficiency (AMEE)

The main missions of AMEE are to propose national, sectoral and regional plans for the development of energy efficiency, the mobilization of financial instruments and resources for the implementation of programs related to energy efficiency, among others.

National Authority for Electricity Regulation (ANRE)

This was created through Law n ° 48.15 relating to the regulation of the electricity sector. To be considered a legal person under public law with financial autonomy, the entity's mandate is to ensure the proper functioning of the free electricity market and regulating the access to the national electricity transmission network.

Moroccan Agency for Logistics (AMDL)

Created in July 2011, the Moroccan Logistics Development Agency (AMDL) is a public institution with legal personality and financial autonomy. Its mission is to manage and coordinate actions to improve logistics competitiveness.

National Authority for Moroccan Highways (ADM)

The National Society of Highways of Morocco or Highways of Morocco (ADM) is a public limited company responsible for operating the Kingdom's motorway network, including mandates of construction and maintenance.

Energy Engineering Company (SIE)

The Energy Engineering Company is a state-owned energy service company, a public instrument whose mandate is to sustainably reduce the energy consumption of public and private organizations while improving their energy performance.

It acts exclusively for the implementation of energy efficiency projects in the direction of essential sectors, including sustainable mobility.

Automotive Industry

Private and commercial vehicles:

The automotive industry in Morocco is predominantly focused on cars. However in 2017, a memorandum of understanding was signed with Chinese manufacturer BYD, providing for the construction of an electric bus production plant and an electric train production plant.

With regards to light duty vehicles, the following highlights of developments are notable, which may relate to the enabling envirionment for other vehicle categories in the future:

- The car market in Morocco consists of 34 brands, marketed by importers / distributors
- In 2017, 3 brands marketed electric car models in Morocco, namely Renault (Full electric: Twizy, Zoe, Kango ZE), Volvo (PHEV: XC90, XC60), Honda (PSHEV: insight)
- In 2018, other brands brought to market models of plug-in hybrid cars BMW, Hyundai, Porsh
- In 2019, other models of electric cars are marketed in the Moroccan market by the Peugeot and Citroën brands
- Toyota has been moving towards full hybrid since 2017
- Renault produces cars in Morocco for the local and export market through its Renault Tanger Méditerranée plant since 2013. The production in 2017 was 300,479 units.
    - Discussions are underway with Renault
- PSA will produce cars in Morocco from 2019 through its factory in Kenitra (in progress), with a production capacity of 100,000 units and a projection of 200,000 units in 2020
    - Africa and Middle East market oriented production
    - First, a production-oriented diesel generation euro 4 euro 5
    - A modular production platform capable of producing full hybrid and electric vehicles (full electric and plug-in hybrid), to support the evolution of demand
    - PSA is convinced that the world market will gradually switch to all electric by Horizon 2030
- In 2017, Morocco signed a memorandum of understanding with the Chinese manufacturer BYD for establishing an electric car factory near Tangier, to be followed up with an electric battery factory.
- Other manufacturers will be able to take the plunge and produce in Morocco, such as Renault and PSA, taking into account the orientations of the State within the framework of the Industrial Acceleration Plan.

Electricity production and distribution

Key players in electricity production are as follows:

- National Office of Electricity and Drinking Water (ONEE) is a public establishment created in 1963. It carries out activities focused on the electric energy production, transport and distribution.
- TAQA Morocco, private company and supplier to ONEE, produces 50 percent of national electricity production.
- Private organizations are also allowed to generate electricity but only from renewable energy sources.

The network manager in charge of delivering electricity to consumption facilities in Morocco is exclusively ONEE. Law N° 48.15 relating to the regulation of the electricity sector provides for the creation of an entity dedicated to the management of the national electricity transmission network within ONEE.

ONEE has a market share of over 50 percent in terms of electricity distribution, while the rest goes to the other players through delegated managers and autonomous authorities.

ONEE and the delegated managers and autonomous authorities market electricity. Electricity produced from renewable energies can be marketed by private producers.

Research organizations

Institute Research Energy Solar and Energy Nouvelles (IRESEN)

IRESEN is a research institute created in 2011 by the Ministry of Energy, Mines, Water and Environment, and several key players in the energy sector in Morocco to support the national energy strategy through applied R&D in the field of solar energy and new energies.

Among the projects initiated by IRESEN are those pertaining to electric cars; prospects to cater to research for other vehicle categories are also on the anvil. Projects include the following:

- Installation of the first solar-powered electric vehicle charging shade solar in Rabat
- Installation of the first charging terminals on the Tangier-Agadir motorway

Associations / Federation / NGOs

Energy Federation

The Energy Federation is an association dedicated to promoting environmentally friendly technologies, maintaining energy databases and documents, and cooperating with national and foreign bodies concerned with energy. It contributes with relevant studies from its repository of knowledge about sustainable mobility.

Moroccan Vehicle Importers Association (AIVAM)

It is an association of vehicle importers; it has statistical reports on vehicles and importers

Development Agency and Donators

GIZ Maroc - German International Cooperation Agency

Since 2008, GIZ has supported its Moroccan partners in the implementation of the national Renewable Energies strategy, as part of a portfolio that is constantly expanding. Funding volumes are increasing, so as to meet the needs of Moroccan partners and to cover the three main themes of this sector:

- Support for Morocco's energy policy;
- Development of RE/EE at the national level;
- Promotion of RE/EE at regional level.

French Agency for Development (AFD)

Partner of the Kingdom since 1992, AFD mobilizes all its tools – donations, loans, guarantees, technical assistance – to act in several key sectors, including energy transition. It is therefore one of the main partners of public authorities and private actors in the country.

The Energy Federation is an association dedicated to promoting environmentally friendly technologies, maintaining energy databases and documents, and cooperating with national and foreign bodies concerned with energy. It contributes with relevant studies from its repository of knowledge about sustainable mobility.

Others

- European Investment Bank (EIB)
- The World Bank (WB)
- European Union(EU)
- Africa Development Bank (AfDB)
- Islamc Development Bank (IsDB)
- Sharing Stations operators such as fuel distributors like Shell, Total maroc, Afriquaia, Winxo, among others
- Car rental companies such as VTEEN LDD, ArvalMaroc, ALD Automotive, and so on.
- Banks and insurance companies
- Services providers such as M2M

5.8 Market overview and situation analysis

Vehicle Stock and Buses

High-capacity public transport in Morocco has predominately been buses – mostly 12m in size, making up to 95 percent of the buses. The electric tramways have been a more recent addition. The bus stock of 5,064 is almost entirely diesel-fueled, predominantly Euro-4 and above, while only 18 buses are electric to date. Low-sulphur diesel allows high Euro standards in heavy-duty vehicles in Morocco.

For the fleets of public passenger transport buses specifically, the vehicles are classified into three categories:

- "A" for vehicles with 40 seats or more,
- "B" for vehicles with 16 to 39 seats and
- "C" for vehicles with 15 seats and less (vans).

There are 2,783 buses, of which 2,291 are in operation. The vast majority of the fleet includes vehicles with 48 to 54 seats, constituting 81.3 percent. The stock age is old 40 – percent is over 15 years old and 28 percent between 10 and 15 years old[157].

By the end of 2018, the combined public fleet of the State, Public Establishments and Enterprises, and Territorial Collectives, consisted of 265,000 vehicles. The annual growth rate of vehicles by 2018[158] was approximately 5 percent a year; it has further accelerated since.

Vehicle registration centers received an average of 30 percent of vehicles until 2018, when they received 57 percent, and where the total of these vehicles fell by -16%.[159]

Table 21: Vehicle stock per category

Vehicle Category	2014	2015	2016	2017	2018
Motorcycles	41 101	43 220	55 517	130 257	191 611
Passenger vehicles	2 423 609	2 531 753	2 670 614	2 808 782	2 950 056
Commercial Vehicles	973 238	1 015 245	1 065 338	1 117 559	1 170 177
Total fleet	3 437 948	3 590 218	3 791 469	4 056 598	4 311 844

Source Ministère de Transport

The following table presents more details on the fleet in 2017 as per available information.

Table 22: Example of fleet segmentation in 2017 and corresponding sub-categories used in Morocco

Vehicle segment	Fleet 2017	Further details by segment
Private vehicles	2,808,782	77,280 taxis (45 280 Large taxis et 32 000 small taxis)
		141,000 rental cars including 29,000 long-term
Commercial vehicles	652,876	642,244 Light Commercial (GVW <= 3.5 T)
		5,523 Car - Regional bus ('Autocar')- Mini car
		5,109 Autobus-Bus-Mini bus
Motorcycles	1,230,257	900,000 mopeds (estimate)
		130,000 motorcycles over 50cc (registered)
		200,000 motorized three-wheelers, 'tricycles' (2016 estimate)

Source Ministère de Transport

The main brands of heavy-duty vehicles (HDVs) sold in Morocco are: Volvo, Isuzu, Fuso, DAF, Irizar, Iveco, Rebel, Renault Trucks, FAW, Otokar, Bennes Marrel, Mercedes, MAN SEFAMAR, Hyundai, Scania.The supply of public transport vehicles in Morocco consists of 15 brands with most substantial presence of Hyundai, Scania and Volvo in terms of bus fleets of different sizes.

Market size and competition

Sales of urban and regional buses registered in Morocco were 595 units in 2016, with an increase of 44 percent between 2014 and 2016.

Table 23: Annual sales of buses throughout 2014-2016

	2014	2015	2016
Personal transport bus	207	199	298
Regional bus	63	76	68
Urban Bus	144	123	229
Total	414	398	595

Source Groupement du poids lourd et de la carrosserie (GPLC)

79 percent of the urban bus and minibus market is held by Hyundai, while Volvo holds 75 percent of the coach and minibus market.

Market share of the main brands of buses and coaches in Morocco (2016)

Table 24: Example of market share of main brands of buses in Morocco (2016)

	SCANIA	VOLVO	Hyundai
Regional Bus	25%	75%	0%
Urban bus (<40 seats)	0%	0%	100%
Urban bus (>40 seats)	70%	30%	0%

Source: GPLC

The main brands of heavy-duty vehicles (HDVs) sold in Morocco are: Volvo, Isuzu, Fuso, DAF, Irizar, Iveco, Rebel, Renault Trucks, FAW, Otokar, Bennes Marrel, Mercedes, MAN SEFAMAR, Hyundai, Scania.

The supply of public transport vehicles in Morocco consists of 15 brands with most substantial presence of Hyundai, Scania and Volvo in terms of bus fleets of different sizes.

Considerations for total cost of ownership

In this section, overview of cost ranges is discussed to put into perspective the cost comparisons between EVs and diesel-fueled vehicles in Morocco in terms of purchase prices and energy costs.

A full-electric bus of 18m size would cost within the range of USD 750,000-785,000 USD, while a similar diesel bus would cost approximately USD 480,000. This price difference indicates that the electric bus is approximately 60 percent more expensive than a comparable diesel bus. Likewise, a similar large difference is observed in other bus sizes.

With regards to diesel fuel prices, during the period 2015-2020, the selling price of diesel fuel fell within the range of 7.45-9.7 DH/l (0.83–1.09 USD/l) It has been varying since 2016, every two weeks.

With regards to costs of charging, the medium voltage electrical energy tariffs for professional use – estimated for the period 2017-2020 – averages just about at 0.95 and 0.96 DH/kWh during winter and summer respectively, i.e. 0.11 USD/kWh.

With such price differences in the main operational cost, the difference can be up to *four-fold* per kilometer, depending on the efficiencies of the vehicles compared. This significant difference indicates a favorable TCO for electric buses as their prices decline.

Barriers to entry and uptake factors

There are various strengths that position Morocco in a relative advantage to many countries in the MENA region as follows:

- National Strategy for Sustainable Development by 2030
- Energy Efficiency 2030 Strategy Project
- Sustainable mobility roadmap (in progress)
- Paris Agreement commitment
- Energy strategy based on Renewable Energies
- State exemplary targets (10% of new acquisitions)
- Vibrant automotive industry (e.g. modular production platform within Renault and Peugeot factories in Morocco, cooperation with Chinese companies, and continuous expansion in the automotive industry towards cleaner vehicles).

However, numerous hindrances to the development of e-mobility still need to be addressed. Most barriers to entry and uptake are similar to those of other countries in similar early stages of EV adoption. The key barriers are noted as follows:

Policy and Legislative Barriers

- A sustainable mobility roadmap implemented by the Ministry of Transport with the support of GIZ and SIE is in progress, but a key challenge is in *coordinating* the activity of all ministries and relevant stakeholders to ensure a practical and timely result.
- There is a lack of strategic planning for electric bus systems in specific to scale up pilot projects and other e-mobility modes.

Capacity and Knowledge Barriers

- Limited monitoring and evaluation of relevant projects to support planning and scale-up efforts.
- High dependence on OEMs for planning and limited local know-how necessary for technology selection, city-level planning, e-mobility fleet management, among others.
- Limited availability of local consultants and experts specialized in e-mobility in general or in electrification of bus fleets in specific.

Market and Financial Barriers

- High capital costs for EVs and charging infrastructure, with limited incentives.
- Tendering and procurement procedures are not yet amended to incentivize EVs.
- Limited offer of EVs and after-sales services.
- Possible impact on the spare parts and after-sales service market, and implied resistance from the conventional ICE automotive industry.
- Substantial resistance from taxi drivers towards promotion of modal shift in favor of collective transport.

Technical Barriers

- Key technical barriers are those associated with grid integration in the case of scaling up. This requires adequate planning for ramp-up in demand and choice of charging strategies and technologies, in addition to the possible needs for grid reinforcements.
- In the case of electric trolley buses, a technical barrier in expansion is the limited *route flexibility* of such an option when needed, as well as space and right-of way constraints.
- Challenge in adequate assessment of traffic demand and corresponding design of routes and operational plans to optimally match supply with demand.

Case study: e-BRT of Marrakech

Marrakesh is the fourth largest city in the Kingdom of Morocco with a population of 1.3 million in its metropolitan area, and is a major economic center and tourist destination.

Motivated by its position as the city hosting COP22 in 2016, the city embarked on a project of a pilot electric BRT line, in-motion charging trolley buses, to showcase efforts for innovative climate action in the transport sector as a flagship project.

Project description

BRT Marrakesh is a bus rapid transit system that is also partly trolleybus operation since 2017, with a fleet of 15 high-capacity trolley buses of 18m length. Of these,10 buses initially came from Chinese OEM Yangtze Motors.

The buses are owned by Société de Développement Local (SDL), local development company executing the municipal project, and operated by ALSA Marakech. This first BRT line was planned to serve 60,000 passengers per day in its third year of operation.

It is notable that ALSA Morocco is a leading operator throughout the country operating fleets in 6 big cities; Marrakech, Agadir, Tangier, Khouribga, Rabat and Casablanca.

The system is officially known as *Bus à Haut Niveau de Service de Marrakech* (BHNS de Marrakech), which in English translates into the Bus Rapid Transit of Marrakesh.

Although the buses are equipped to operate as trolleybuses, only part of the system is fitted with overhead wiring for trolleybuses, and the vehicles are powered purely by batteries in other sections.

The initial route in operation runs from *Bab Doukkala* in the city center to *Al Massira*. It is marked as route-A at stops, but trolleybuses in service display only *BRT1* on their destination signs. This route is 8 km long, of which 3 km are fit for trolleybus-mode operation.

The vehicles run on batteries in the other sections, which are intermittently recharged from the overhead trolley wires (in-motion charging). Other lines are expected to start operations in the future.

Solar Power

Solar Photovoltaic generation has also been developed to partly power the system. This component has been developed through a GEF-funded project, *Renewable Energy for the City of Marrakech's Bus Rapid Transit System,* with support from UNDP. It was executed through the Secretariat of State for Sustainable Development, and involved installing a 750 kW_p solar park using innovative solar tracking technology[160].

Operation

The BRT Marrakesh project has had a relatively successful run. However, lack of sufficient ridership has persisted as a challenge. This is partly due to mismatches in planning of routes and operational plans with the nature and spatial distribution of the actual travel demand. As a result, hotspots of origins and destinations have not been adequately incorporated. This has translated into a significantly reduced use of the stock of electric buses, implying suboptimal use of assets with implications on battery life as well as actual carbon reduction impact.

Lessons learnt

There has been limited information on the project in terms of monitoring and evaluation of fleet operations, indicating the need for better technical support and dissemination of lessons learnt in the stage ahead. However, there is no doubt about the proof of concept.

The component associated with renewable energy has been subject to adequate evaluation. It sheds light on the success of integrating solar energy into the e-BRT plans – from both the promotional and the functional standpoint.

A terminal evaluation of the renewable energy project was conducted and it recommended scaling up. The initial phase of the project with 10 e-buses partly powered by solar power were estimated to reduce 952 tons of CO_2 compared to the business-as-usual diesel buses. The report also noted the following indicative example for consideration of scaling up in Marrakech or elsewhere in Morocco or in other African cities:

For the purchase of 48 electric buses (18 meters long), including 44 in operation and 4 in reserve on the 4 lines by 2030 and for the installation of a solar installation with a capacity of 5.7 MWp, financing is required for an amount of 82 million USD (695 million MAD for buses, 83 million MAD for solar power plants, or a total of 778 million MAD)

Figure 17: Trolley bus with in-motion charging in Marrakech

Figure 18: Rabat Tramway and Feeder Buses[161]

GEF terminal evaluation report, 2019[160]

Suggestions noted for sources of funding include the Green Climate Fund (GCF) and the Caisse de Dépot et de Gestion (CDG; Deposit and Management Fund). CDG is a state-owned financial institution acting as a large investor.

Case study: Rabat Tramway and prospects for feeder buses

The coastal city Rabat is the capital city of Morocco and the country's seventh-largest city with an urban population of over 1.2 million in its metropolitan area.

For daily travel, the city has a tram network, a bus network and taxis connecting all corners of the metropolitan area.

Project description

The Rabat-Salé tramway is a dedicated public transport system serving the cities of Salé and Rabat in Morocco, implemented as a PPP project. It is owned by The Rabat-Salé Tramway Company and operated by Transdev company as the operator via its subsidiary Transdev Rabat-Salé.

The first two lines of the network opened to the public in mid-2011. The lines are now 27 km long and include 43 passenger stations. Two further extensions to line 2 have been completed in 2020.

The main objective of the project is connecting Rabat to Salé with a dedicated lane for tramway and address the problem of travel between the two neighboring towns.

The cost of the project is estimated at DH 3.8 billion (USD 430 million), with co-funding from STRS, the agency for the development of the Bouregreg valley (AAVB), and through the Emerging Countries Reserve (RPE) from the EIB and AFD, as well as the EU.

Currently, between 130,000 and 140,000 passengers use the tram on average per day. About half of these are students.

Many cities in Morocco have tended to go toward tramways as a clean technology. However, opportunities for further improvement can also be exploited by cleaning the fleets of feeder buses (see Figure 18) through electrification. Bus operator ALSA alone is operating 350 buses in Rabat[162].

Another notable city with an expanding potential for diversification of public transport modes is Casablanca, the largest city of Morocco with a population of 3.7 million. It is a promising candidate for early adoption of novel technologies among its mix of public transport options, including the existing bus system, taxi fleet, and an expanding tramway network. The tramway network, the Casablanca Tramway, consists of two lines of 47 km and 71 stations, while two more lines are due to operate in 2022. Plans are afoot for the launch of *High Service Level* bus lines, through PPP schemes, for which *Casa Transports*, a limited company was created in March 2009[10].

Lessons learnt

This project indicated that the legal and regulatory framework to implement a PPP project is well in place to implement clean transport projects such as the electric tramway. Even though the primary motive has been to connect the cities of Rabat and Salé, there is no planning yet to promote cleaner fleets of the feeder buses, which expose citizens to air pollution more. Therefore, projects such as the tramway in Casablanca are appropriate for expanding electric mobility across different modes and also for distribution of grid impact throughout other hours of the day (e.g. in the case of overnight charging).

10. Shareholders of Casa Transports SA include the State (Ministries of the Interior and Finance), local communities (Region, Prefecture and Urban Commune of Casablanca) and large institutions (HASSAN II Fund, CDG, BCP and ONCF).

5.9 Recommendations for planners and development partners

There are many indicators that Morocco's performance with respect to its pursuit of sustainable transportation is commendable. The power grid is improving continually in terms of RE shares, vehicle standards are relatively good within the MENA region, fuel quality is sufficiently satisfactory, and the move torwards electrification is substantial, even if mostly by way of electric tramway systems. To build on such momentum, key recommendations are enlisted below.

Policy and Legislative Recommendations

- Revise city-level sustainable urban mobility plans (SUMPs) for cities that have not yet developed it or updated it in accordance with recent developments in the sector, and align plans with national and corporate mobility targets, including targeting enhancing local production of EVs or EV components.
- Set explicit targets for diesel consumption reduction or phase out at the national level and city levels.
- Integrate the existing procurement electrification targets – 10 percent of public procurement – with additional necessary policies, such as stricter emission standards and targets for diesel consumption reduction, targets for electrification of other types of high-use buses such as school buses, commercial buses, incentives for modal shift, and setting targets for modal share, among others.
- Develop a tariff scheme and associated regulations specifically tailored to the promotion of electric buses and vision for scaling up.
- Consider establishing Low-Emission Zones in major cities.

Capacity and Knowledge Recommendations

- Improve adequate availability and public access to updated and relevantly disaggregated vehicles data and information for both research and for transparent monitoring and evaluation of progress. This could be by way of developing a data warehouse, or an online MRV system, alongside ongoing efforts for digitization in the transport sector.
- Develop locally tailored tools for supporting city-level planning for fleet electrification and provide training for local consultants and public authorities on technology selection and system-level planning, TCO analysis, business model development, tendering and procurement, among others.
- Enhance monitoring and evaluation of existing and prospective initiatives in process to enable adequate scaling up. This should not be only in the form of MRV (measurement, reporting and verification) for GHG reduction, but evaluation of all elements of sustainable mobility.
- Develop and disseminate locally tailored educational and experience-exchange content through multi-channel capacity development programs.
- Provide targeted training for new job opportunities expected.

Market and Financial Recommendations

- With support of climate finance, provide subsidies to address the barrier of high up-front costs of electric buses, among other suitable incentives such as tax and custom duties exemptions.
- Expand and diversify the technologies selected in pilot projects adopted in the early stages of e-mobility promotion in public transport, in collaboration with OEMs that may offer support.

Technical Recommendations

- Develop a grid impact assessment to plan for EV ramp-up scenarios and to understand potential grid enhancement needs. Opportunities must also be explored of sector coupling (vehicle-to-grid integration), in addition to the integration of electrification plans with Morocco's energy transition.
- Optimize the existing robust grid infrastructure developed for the electric tramway systems in Morocco to synergize with infrastructure needs for electric buses, and reduce costs and enhance the digital infrastructure for future-proofing of new e-mobility projects.

Throughout the process of exploring the situation of public transport and bus systems in the three case-study countries, and within their respective larger context, there are multiple identified opportunities for experience exchange.

- Egypt provides sound examples of the following:
  - Major road upgrades throughout the nation, which can be a positive or a negative transformation, depending on the accompanying measures. This can diverge into two possibilities: a phenomenon of induced car traffic if no restrictive measures are imposed, or a facilitation of *on-road* public transport (buses mainly) of higher service quality and comfort with improved roads, thus encouraging the necessary modal shift. The latter is intended, but the necessary mix of measures is still not public.
  - Progress in promoting gradual partial local production of electric vehicles through cooperation with leading OEMs, and mobilization of underutilized state-owned facilities. Although this is not directly associated with market penetration and rollout of EVs, this facilitates decision making regarding incentives for EVs. The implied boost to the local industry can help planners favorably determine issues such as exemptions, procurement mandates in the future, among others.
- Jordan provides good examples of the following:
  - Private sector engagement in electrification of fleets, of which Aramex vans are a case in point. These can be replicated in other medium-duty vehicle types. But it also exposes the limitations to scalability, which can be addressed by ensuring certainty about regulations and incentives.
  - Leveraging high-visibility areas such as cultural heritage sites, natural protectorates – in Petra and

One of the major challenges in the three countries is the lack of relevant data for planning for e-mobility and monitoring changes and progress. Therefore, city-level or fleet-level in-depth studies are recommended in early transitional phases, alongside attempts to develop or refine national-level strategies.

the Giza Pyramids plateau for example –to attract OEMs for subsidized or promotional pilot projects novel technologies.

- Morocco provides a good example of the following:
  - Decentralization and autonomy in city-level mobility planning, including development of Sustainable Urban Mobility Plans (SUMPs) in major cities with support of international development partners including GIZ.
  - Successful implementation of an adequate legal and regulatory framework for implementation of PPP projects.
  - Ensuring high standards for diesel buses requirements (Euro standards) with corresponding availability of high-quality fuel.
  - Experience in leveraging climate finance to support an e-BRT project, and experience in piloting relatively novel technology of the electric trolley buses. This is a commendable option that can be explored elsewhere; it implies lower costs of batteries that are often imported.
  - Experience in showcasing the concept of linking renewable energy to e-mobility to reduce grid emissions.
  - In estimating the relative cost savings associated with electrification, Morocco is likely to perform the best according to current prices of fuel and electricity in the three countries. Detailed TCO analysis are needed for specific cases and scenarios of interest[11]. However, for *indicative* purposes, the following approximations are noted[12]: (a) In Egypt, OPEX costs of diesel is more than double of electricity cost per km, but CNG is similar, (b) In Jordan, OPEX costs of diesel is also 60-80 percent higher per km (c) In Morocco, ./the difference is highest with diesel approximately four times the cost of electricity per km. Relative savings within the country are therefore highest in Morocco. But foreseeable pricing interventions can largely influence the scenarios – for example, electricity is subsidized specifically for the Metro line in Egypt.

One of the major challenges in the three countries is the lack of relevant data for planning for e-mobility and monitoring changes and progress. Therefore, city-level or fleet-level in-depth studies are recommended in early transitional phases, alongside attempts to develop or refine national-level strategies.

Another common challenge across the three countries identified during stakeholder consultations is the common mix-up between what is required for electrification of *buses* and what is required for light-duty vehicles, mainly cars. There is also the confusion between measures necessary for manufacturing and measures for roll-out of EVs. This is a priority area that can be addressed throughout any prospective *capacity building* activity and in production of *locally-tailored* educational material. Educational content can be ideally developed around hypothetical city-level electrification projects in each country to ensure its relevance in engaging with stakeholders and converging toward common understanding and vision for transition to e-mobility.

Furthermore, support for the development of SUMPs through on-job training, south-north and south-south experience exchange in select cities of Egypt and Jordan, and exchange with Morocco, would be of great benefit. Accordingly, cooperation is provided to target the greater context of sustainable mobility in a holistic manner advocated by the principles of SUMPs.

11 In TCO analysis, necessary on-road testing data would be needed due to expected wide variation in technologies as well as differences between driving cycles and differences between manufacturer's data and actual performance and various charging strategies and operational requirements.

12 CEDARE analysis.

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