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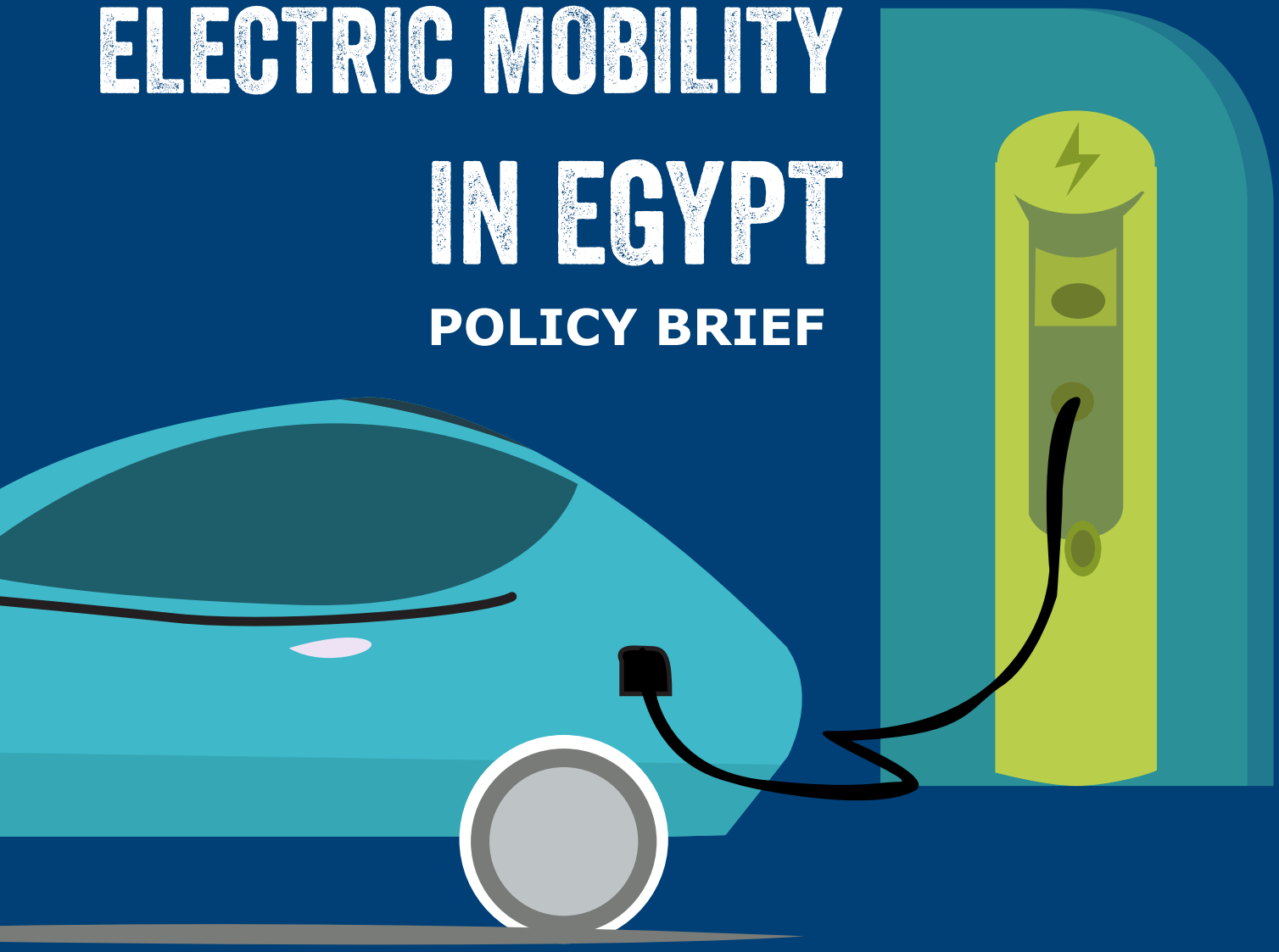
CEDARE

MAINSTREAMING ELECTRIC MOBILITY IN EGYPT

POLICY BRIEF



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POLICY BRIEF

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*Mainstreaming Electric Mobility in Egypt 2018

About Friedrich-Ebert-Stiftung (FES) in Egypt

Inspired by its general aims to promote democracy and social justice, to support economic and social development, the Friedrich-Ebert-Stiftung (FES) started working in Egypt in 1976. For almost 40 years, the office operates in cooperation with local partners within the framework of an agreement with the Egyptian government. This agreement was endorsed by Presidential Decree 139/1976 and by the Egyptian parliament. The agreement was renewed in 1988, endorsed by Presidential Decree 244/1989 and approved by the Egyptian parliament.

In March 2017, a new Additional Protocol was signed in Berlin by both, the Egyptian and the German governments, amending the Cultural Agreement of 1959. This protocol was ratified by the Egyptian parliament in July 2017 and entered effect in November by Presidential Decree 2672017/.

The FES cooperates with Egyptian partners in the fields of:
Environment & Sustainable Development
Socio-economic Development
Empowerment of Civil Society
Cooperation and International Dialogue

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About CEDARE

Center for Environment and Development for the Arab Region and Europe (CEDARE) is an international not-for-profit diplomatic organization based in Egypt. It was established in response to the convention adopted by the Council of Arab Ministers Responsible For the Environment (CAMRE) in 1991, and upon the initiative of the Arab Republic of Egypt, the United Nations Development Programme (UNDP) and the Arab Fund for Economic and Social Development (AFESD).

The mission of CEDARE is to provide leadership and advocate sound governance for sustainable development, through building human resources and institutional capacity, advancing applied research and environmentally friendly technologies and acting as a catalyst to enhance collaborative action between the Arab World, Europe and the International Community.

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EXECUTIVE SUMMARY

- This policy brief aims to consolidate the various relevant policies and initiatives that cater to EV deployment in Egypt to date and provide recommendations for the way forward. This has been developed in a participatory manner through consultations with stakeholders of the public and private sector.

- Addressing transport sector fuel consumption and emissions is a priority among planners and policy makers in Egypt, especially given the fiscal burden of fuel subsidies: **EGP 110 bn** had been allocated to subsidize petroleum products in 2017, with most burden attributed to the largely imported diesel fuel. With **9.3 million vehicles** in Egypt, half of which are private cars, there is an urgency for planning alternative solutions within the *Avoid-Shift-Improve* framework of sustainable mobility. Introducing electric vehicles (EVs) is recognized as a promising ***contributor* to the broad mix of solutions**.

- **Numerous indicators** note that there is substantial interest and engagement from public and private stakeholders in initiating the deployment of EVs in Egypt: **Custom duty exemption** for electric cars in place since 2013 (and maintained in 2018 provisions), public procurement of **full electric buses** in the pipeline in Alexandria, and **charging stations** being rolled out starting with demonstrational stations in Cairo, and elsewhere, as well as initiation of EV and charging station assembling and manufacturing activity and plans for batteries production, and lining up after-sales services. In most recent developments, a further incentive of allowing import of used vehicles has been initiated by a decision by the Ministry of Trade and Industry to allowed import of used cars, although the policy impact must still be investigated (e.g. to assess and mitigate the risks related to introducing used batteries).

- Activities however remain ad hoc and need coordination under a common vision (leading to facilitating policies and regulations and deployment of infrastructure), which is an effort that can be ideally initiated by the Egyptian Environmental Affairs Agency (EEAA).

- Further motivation is that **Egypt's grid emission factor** shall decrease (i.e. cleaner electricity in terms of CO_2) due to planned efficient Combined Cycle Gas Turbines (CCGT) power plants, and expansions in new and renewable energy in the pipeline, which further magnifies the benefit of EV deployment when compared

to conventional vehicles, or even natural gas powered vehicles.

- When introducing EVs, **high-usage, high-occupancy vehicles** should be prioritized in order to maximize relative benefits (taxis, buses, microbuses, tuktuks, ride-share and car-share fleets, company fleets, etc), due to the improvement of the relative Total Cost of Ownership (TCO) (i.e. the comparison with gasoline/diesel vehicles generally *improves* when the EV is being used more throughout its lifetime).

- For fleet renewal, **Diesel-fueled vehicles** (buses, microbuses, etc) in specific should be prioritized over gasoline-fueled vehicles due to (a) the very high **sulfur content** in Egypt's diesel fuel leading to public health concerns, (b) the higher **fiscal burden** of diesel subsidies due to import reliance.

- The approach of **vehicle scrapping and *replacement*** rather than merely market penetration of EVs is recommended in order to accelerate the improvement of the average fuel economy and emissions of the overall vehicle stock, curb congestion (replacing vehicles rather than adding), and stimulate the automotive sector.

- A major **blind-spot** in planning for cleaner vehicles is data about the stock dedicated to **informal transport** use, such as tuktuks and 9-seat buses, etc (vehicle types and numbers, routes, fuel consumption, job opportunities and social aspects, etc), which requires dedicated baseline studies to inform policy makers and planners. This would also facilitate the transition toward formalization of the sector.

- Together with the policy recommendations, next steps in terms of studies should be the development of a baseline assessment to enable monitoring, evaluation and reporting of any implemented interventions, and to provide basis for objective planning and modeling. This demands **improved data collection and sharing** as well as **harmonizing nomenclature/definitions between public authorities**. This *ongoing* effort would likewise facilitate Egypt's UNFCCC reporting commitments as well (biennial update reports and national communications).

- In parallel, in order for stakeholders to appreciate the complexity and diversity of the topics that underlie EV deployment, there is necessity to provide extensive **capacity building** and awareness programs (including production of **Arabic content**) as well as **experience-exchange** programs with countries/cities with relevant experiences and similar context.

- **Key policy and regulatory interventions recommended are as follows:**

  - Mainstream EVs throughout **public transport vehicles** (high mileage) in vehicle scrapping and replacement programs (including cars and other vehicle types), in parallel to close **monitoring and evaluation** of operations of APTA's first electric buses starting in late 2018.

  - Include EVs as recognized sustainable products advisable in Egypt's **Sustainable Public Procurement (SPP) policies** in alignment with the guidance document for Egypt's Sustainable Public Procurement

developed in reference to Law 89/1998 for tenders and auctions.

- **Maintain (and market) the government's indicators of commitment to EV promotion** (e.g. custom duty exemption for vehicles or relevant products for local manufacturing, progress in integration in licensing procedures, etc), which shall facilitate access to numerous opportunities of available **technical and financial assistance** dedicated to support climate change mitigation measures, and electric mobility in specific.
- **Expand** the existing incentive of **custom duty exemption**, to not only target **'motor cars'** but also all vehicle types ('**motor vehicles**') and charging equipment as well (so as to include E-buses of various sizes that are currently subject to 40% customs duties, as well as including, electric two-wheelers and three-wheelers, etc, and charging stations), which are all most likely destined to high-usage applications. This is similar to promotional considerations made for renewable energy.
- Establish standards and procedures for licensing and registration of EVs of various vehicle types and integration into the upcoming drafting of **the executive regulations of the new traffic law** under revision (i.e. technical assistance to the Ministry of Interior).
- Introduce **fuel economy labeling schemes** to raise awareness and inform consumers about energy savings and emission reductions, as well as facilitate monitoring and evaluation of vehicle stock emissions and average fuel economy.
- Initiate inter-ministerial coordination and consultations to set the **tariff scheme** for vehicle charging and incentives, and to facilitate the prerequisite studies (e.g. grid impact) and data collection needed.
- Promote EVs (and other sustainable modes) must be done in parallel with private-car **restriction policies** and emission restriction policies in alignment with principles of sustainable cities and communities (Sustainable Development Goal 11).
- Promote electric vehicles and non-motorized transport in **historical and cultural heritage sites, or areas of sensitive ecosystems** strictly in combination with **restriction measures** for conventional vehicles within the same programs (e.g. Low Emission Zones).

1 BACKGROUND

The Friedrich-Ebert-Stiftung in Egypt has been actively fostering environmental awareness and the dissemination of knowledge on sustainable development models with the objective to achieve an ecologically sustainable and innovative green economy. By understanding the importance of reducing CO_2 and GHG emissions and the urgency in combatting climate change, FES aims to showcase innovative and sustainable solutions to mobility problems in MENA megacities, such as mapping public transportation in Amman, Beirut and Cairo. The objective of this collaboration with CEDARE is to work together with the Ministry of Environment of Egypt to assist the public and the decision maker in accessing relevant information that would ultimately result in groundbreaking environmental policies.

Center for Environment and Development for the Arab Region and Europe (CEDARE) has been active in promoting fuel efficiency and quality improvement in the transport sector through the Global Fuel Economy Initiative (GFEI) and Partnership for Cleaner Fuels and Vehicles (PCFV) in partnership with UN Environment and a large network of sustainable mobility stakeholders around the globe, and in close coordination with the Egyptian Environmental Affairs Agency (EEAA) and national public and private stakeholders and civil society.

One of the key findings in studies on vehicle efficiency in Egypt is the limitation of this approach in improving pollutant emissions and fuel consumption on a global level since car ownership (as with other types of vehicles) continue to rise rapidly along with fuel consumption, overshadowing the improvement in efficiency of new vehicles. A paradigm shift is therefore needed, and the most promising alternative to date, from the technology perspective, is Electric Mobility, while further promise is found in various innovations in operational models and shifts towards shared-economy principles along with the broader mix of solutions within the Avoid-Shift-Improve framework of sustainable mobility.

Such concepts were highlighted in the experience exchange seminar held by CEDARE in December 2016*. It was noted that despite the foreseen benefits, there is limited research on E-mobility in Egypt and only scattered information about different activities. The introduction of E-mobility has also been recommended in the promotional policy guidance document developed by CEDARE in 2016[1] leading to the current focus. This policy brief therefore aims to serve as a stepping stone in the discussion of EV introduction in Egypt.

* Full coverage of the seminar can be viewed on Youtube *Channel CEDARE Online.*

Highlights: Egypt's Fuels and Vehicles in Brief

There are **9.3** million street vehicles in Egypt,

almost half of which are private cars

&

a third are motorcycles (approx. **3** million).[2]

Congestion, air pollution, and severe lack of public space in its cities are among the main challenges of sustainability.

46% Private Cars

32% Motorcycless

14% Trucks & Tractors

4% Taxis/ microbuses

2% Other

?!

1% Busses

EGP 110 bn had been allocated to subsidize petroleum products in 2017, highlighting the substantial fiscal burden of fuel consumption.[3] Subsidy rationalization is however underway as part of Egypt's reform policies, and is felt in the steady increases in fuel prices. Diesel fuel in specific is a higher burden than gasoline as it remains largely imported.

With regards to quality, gasoline is approaching Euro standards, while diesel is yet far from such targets, having a hazardous sulfur content exceeding

SO_2

rather than the common level of

5000 ppm > **50** ppm

In the meantime, air quality has been estimated by the World Bank to cost Egypt **EGP 3.3-9.6** bn **(up to 3.2% of GDP)** in environmental and health damage.[4] Consequent impact on tourism is also substantial. Movement towards increased use of public transport is underway, while informal transport continues to fill a large gap in mobility needs. In other market segments, transport network companies (ride hailing services) are also expanding, with the leading player already exceeding **150,000** registered cars alone.

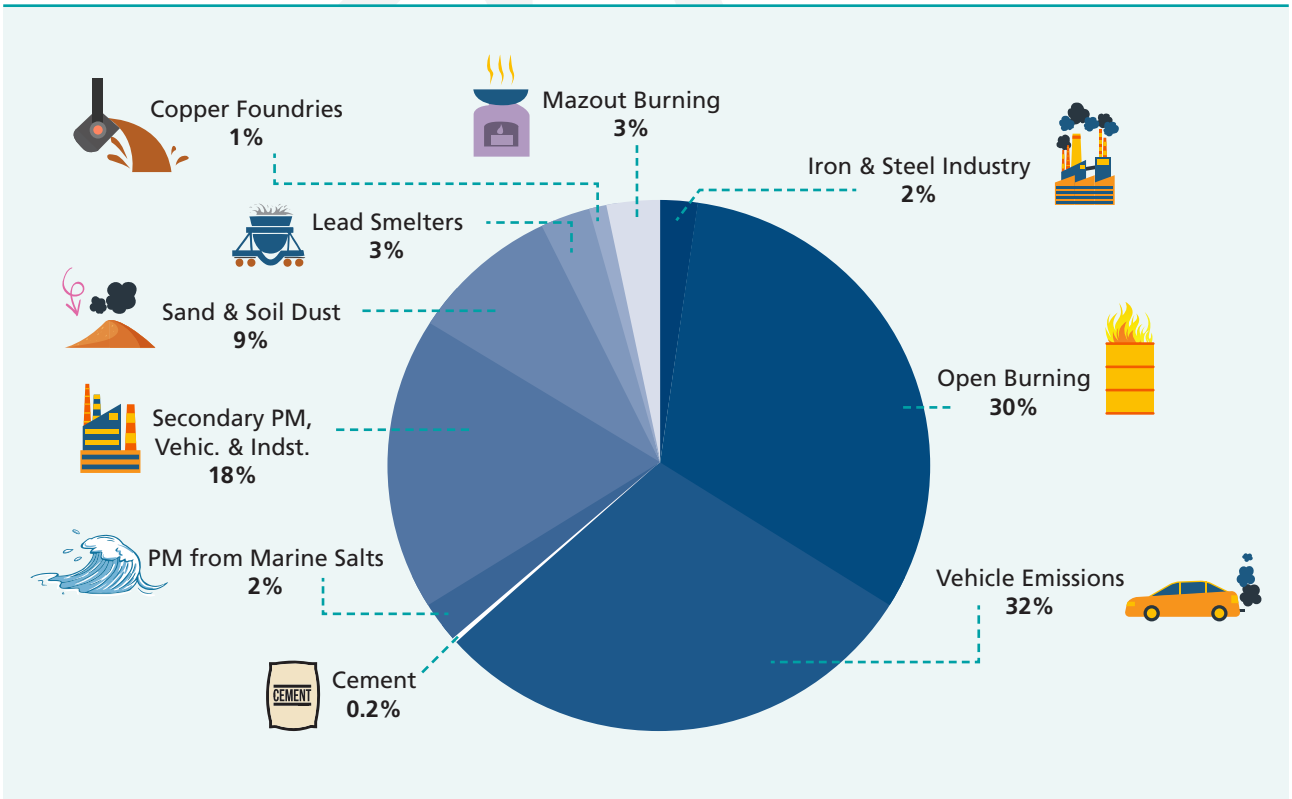
1.1 NATIONAL PRIORITIES

In alignment with the United Nations Sustainable Development Goals (SDGs),[5] and in accordance with Egypt's Vision 2030,[6] Egypt is committed to both reducing emissions of Green House Gases (GHG) to curb climate change and reducing local air pollution emissions for the sake of public health. According to World Bank cost assessment, environmental deterioration and its impact on health has been estimated to cost Egypt an estimated 4.8% of GDP, and the largest contributor is air pollution.[4]

The transport sector in specific, is a key source of different types of pollution, including carcinogens and smog forming pollutants; fine particulate matter (PM2.5), Nitrogen Oxides (NOx) and Sulfur Oxides, Hydrocarbons, soot, …etc.

Furthermore, from the economic viewpoint, the phasing out of fuel subsidies is part of Egypt's plan for economic reform, implying steady increase in fuel prices and thus a pressing need to explore fuel-saving solutions to offer citizens. Even with the foreseen phasing out (or rationalization) of subsidies, the government will still need to reduce fuel consumption in passenger transport in order to save fuel that can be used more profitably elsewhere, such as in export, in industry, or in petroleum-based products.

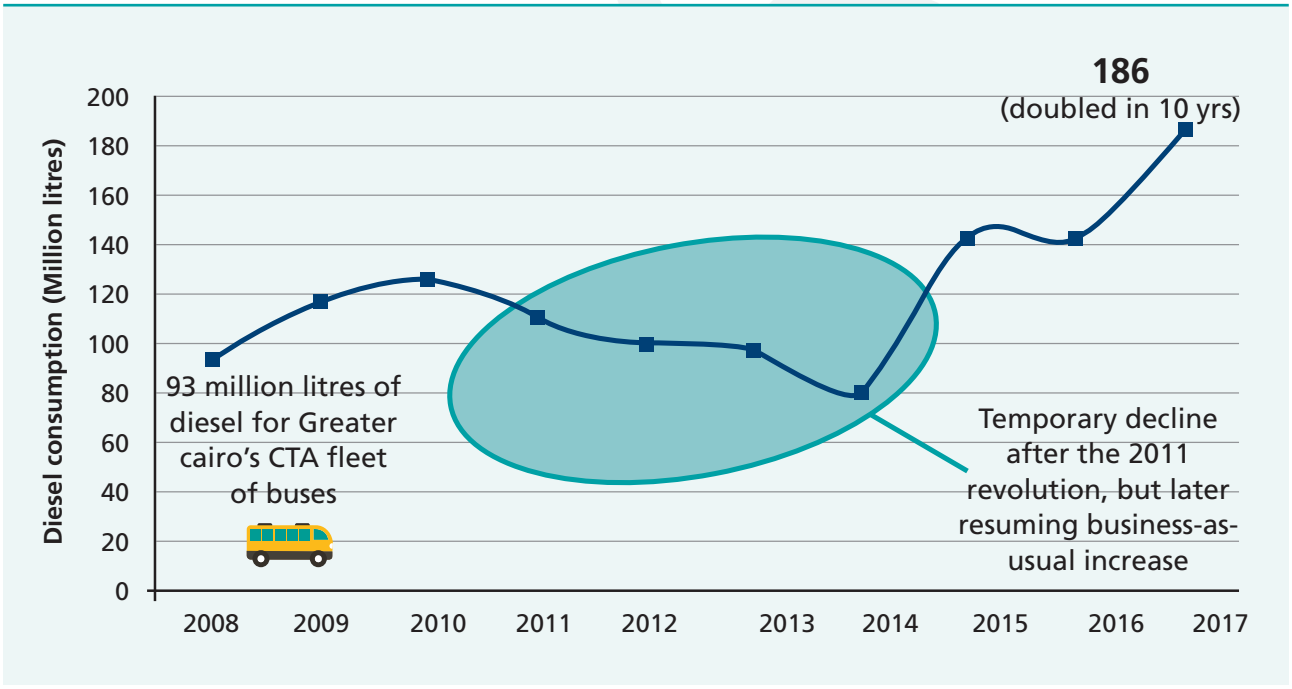
Figure 1: Source-attribution of PM10 air pollution in Cairo dominated by vehicle emissions (USAID, 2004, edited)



1.1.1 Diesel quality and impact in fuel savings and emissions

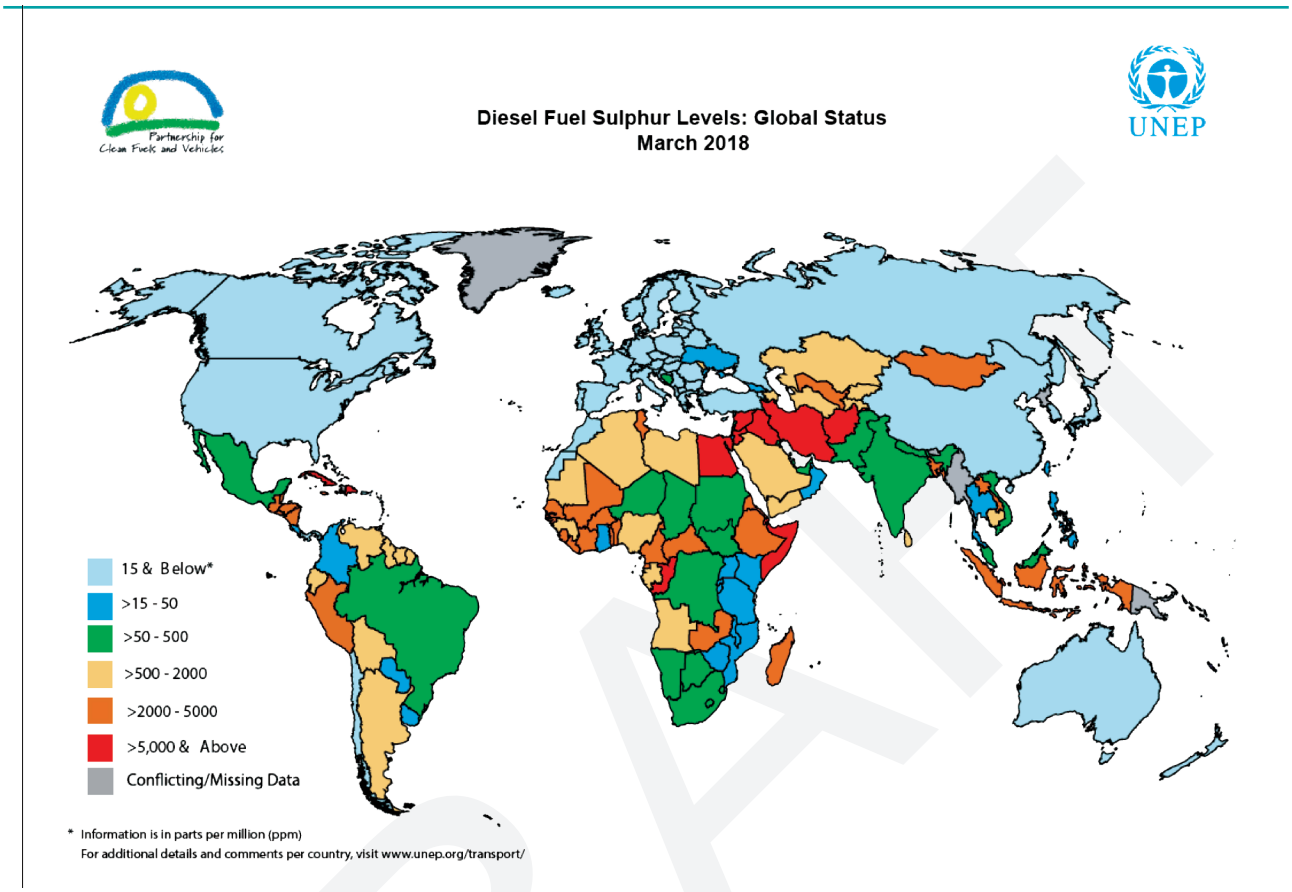
One of the key challenges in Egypt is addressing the low fuel-quality of Diesel fuel in specific, for which the Sulfur content is more than 100 times the international standards; exceeding 5000 ppm (see Figure 3). Sulfur is a catalyst poison; it inhibits the effectiveness of emission control technologies, resulting in increased vehicle emissions of carbon monoxide (CO), hydrocarbon (HC), nitrogen oxide (NOx) and particulate matter (PM), while in itself results in SOx emissions as well.[7] Furthermore, advancements in fuel efficiency improvements 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 microbuses. The fuel consumption of the public buses in Greater Cairo alone has doubled in the past 10 years (see Figure 2), while the diesel quality has remained the same.

Figure 2: Diesel consumption of the Cairo Transit Authority (CTA) fleet doubling in the past 10 years (source: 2018 data, Ministry of FInance)



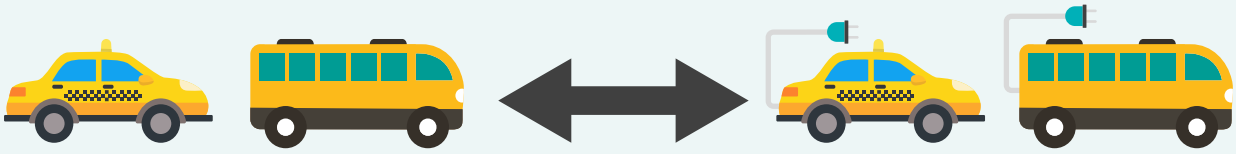
As a reference, the evolution of Sulfur limits in diesel fuel according to Euro standards started with 500 ppm (Euro 2) in 1994, followed by further gradual reduction (350 and 50ppm respectively) to finally reach the latest imposed limit of 10 ppm in 2009 (Euro 5). The global status of fuel quality is illustrated in Figure 3.

Figure 3: Global status of diesel fuel quality compiled by the Partnership for Clean Fuels and Vehicles (PCFV)



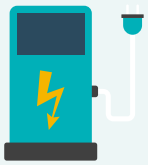
HIGHLIGHT: PRELIMINARY FEASIBILITY STUDY ON EV INTRODUCTION SCENARIOS RECOMMENDS E-BUSES PILOT PROGRAM

In a study commissioned by the Ministry of Environment of Egypt in **2016** preliminary feasibility of taxi and buses replacement was investigated.



Data for electric vehicles was based on real data from a leading EV manufacturer in China, through on-road operation in Shenzhen throughout 2011-2016.

The study recommended that replacing buses should be the priority due to the much higher pollution caused by its fuel type; diesel fuel.



The calculations indicated that for high-mileage buses, the energy savings are substantial: **67%** reduction in the case of Tank-to-Wheel (TTW) consumption.

However, when considering the energy consumptions from the electricity grid, this saving would be less since most of power plants in Egypt today are based on fossil fuels, the percentage would therefore be **12%** in terms of such Well-to-Wheel (WTW) consumption (and **35%** in the case of taxis). This will however increase as new and renewable energy is added to the energy mix of the power sector. Reduction in local pollutants are even higher due to poor fuel quality and aging vehicles.

With regards to emissions, CO2 reductions are proportionally reduced with fuel savings, while reduction in other harmful pollutants (CO, NMVOCs, NOx, SOx, PM) lead to savings in external costs (social impact on health and productivity) exceeding 4 MUSD/yr for the case study of only 100 buses.

Key challenge:

Despite savings in maintenance and fuel consumption, initial costs remain high, so incentives must be put in place for the transition.

Key recommendation:

A pilot program for E-bus introduction, including financial and technical support (such as through climate finance mechanisms).

Source: Mowafi, S. (2016). Preliminary Feasibility Study for E-vehicles in Public Transport in Egypt. Sustainable Transport in Egypt (STE) project, Egyptian Environmental Affairs Agency (EEAA).

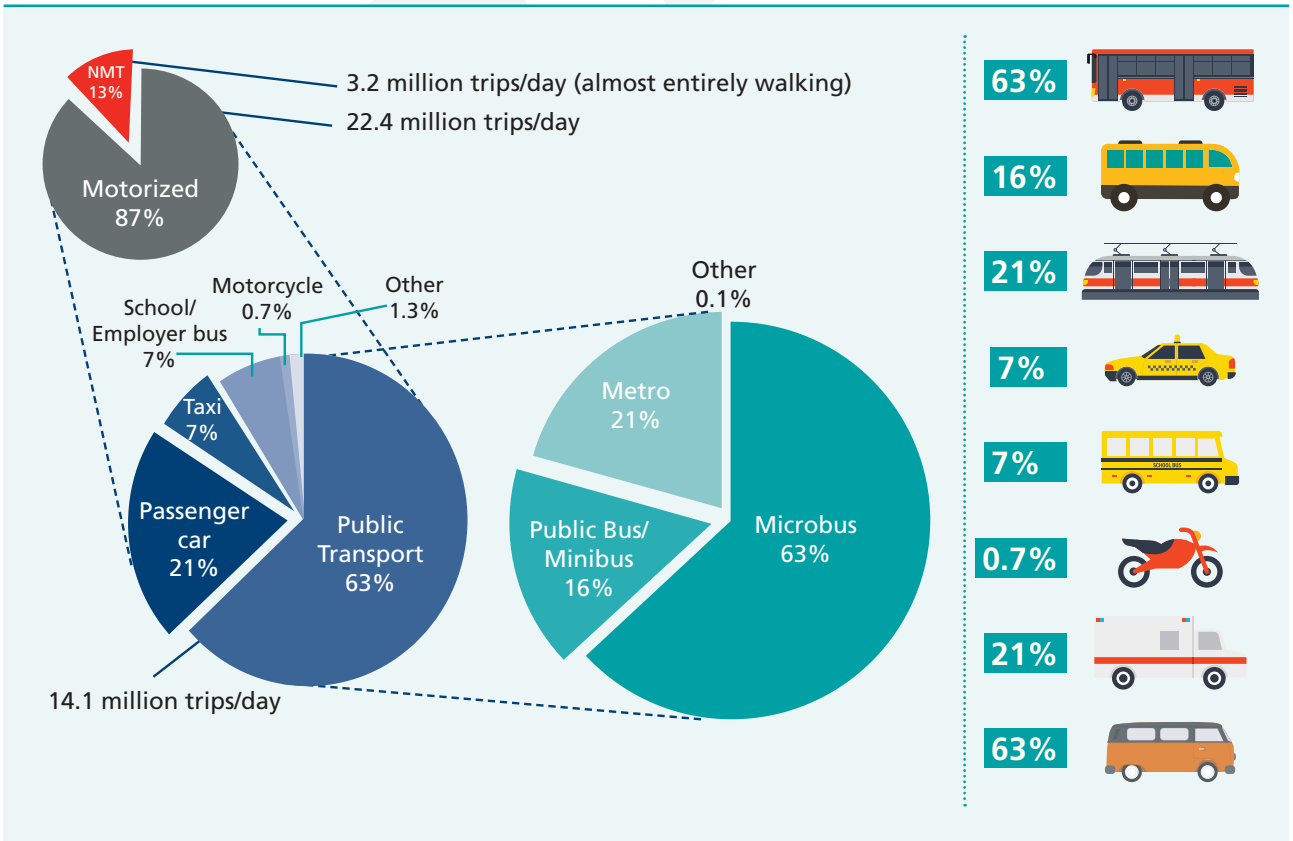
1.2 MOBILITY CONTEXT

Despite the high congestion in Egypt, the private car ownership rate actually remains among the lowest worldwide at approximately 45 cars per 1000 inhabitants. This is an order of magnitude lower than all EU countries, which mostly exceed 600 cars per 100 inhabitant.[8] Even at the level of Greater Cairo Region (GCR), the most congested urban agglomerate, the rate is about double, which is also very low, but also continuing to rise steadily.

The relative evolution of transport in Greater Cairo over the past three decades suggests that the use of passenger cars (including taxis) has increased to now cater to a quarter of all motorized trips, but privately operated microbuses (shared taxis), still dominate the market.

With regards to formal sector bus services, they have suffered an erosion of market share and much of the fleets are beyond residual life.[9] The informal sector on the other hand (predominantly microbuses), appear to have achieved a very strong role in terms of road-based public transport services absorbing near 8.1 million journeys per day at present.[9]

Figure 4: Mode split for Greater Cairo's 26 million trips (>500m)per day in 2014 (Source: Data from model-based update by Egyptian Transportation Centre of Excellence of the Ministry of Transport, based on CREATS, 2002 data updated in 2014)

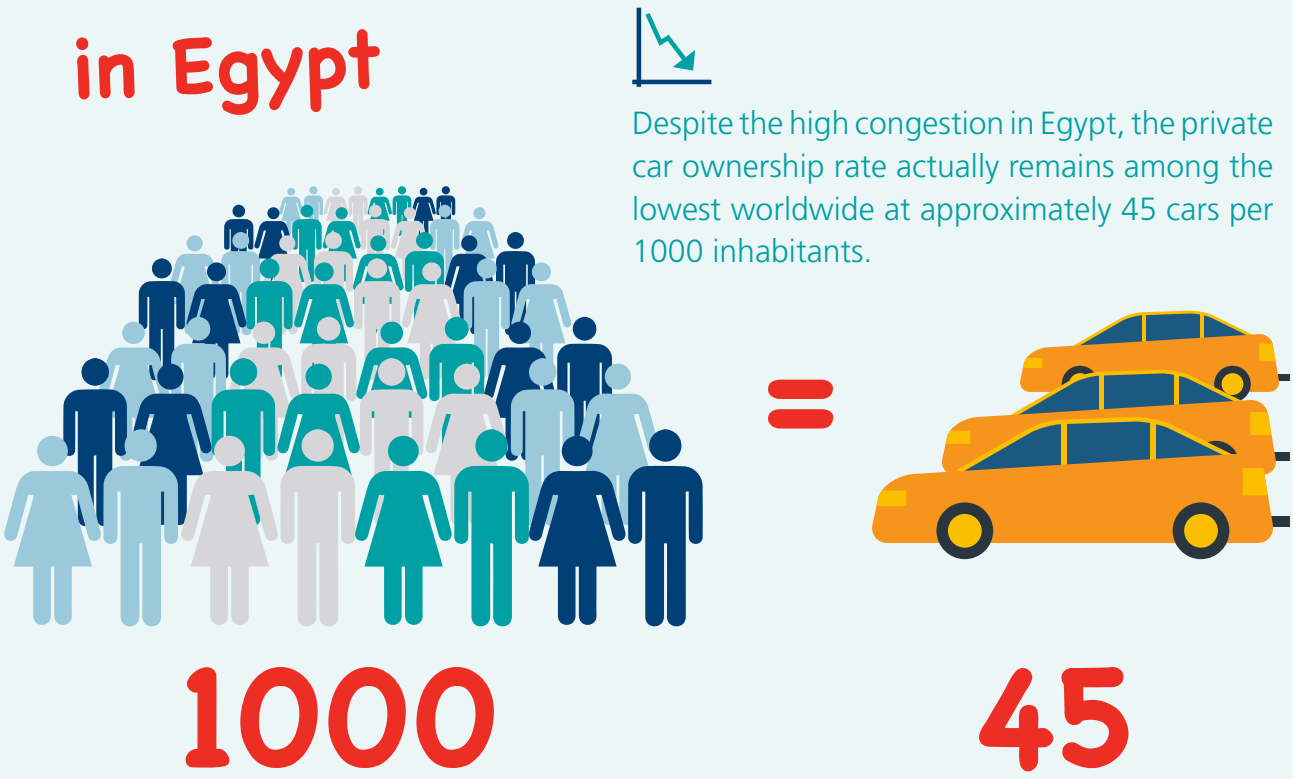


Being at such an early stage of motorization is a great advantage to introduce sustainable mobility solutions.

GCR faces three crucial urban planning challenges as it continues to expand beyond 60-80 km east and west of its central business district:[9,10]

- **Dense inner city:** Redeveloping or restructuring the inner city areas with very high population density (approx. 21,700 persons/km^2) to alleviate economic losses due to congestion, environmental pressures, and loss of public space.
- **New urban communities:** Functionally integrating the expanding new communities spreading over more than 50km from the metropolitan centre. Eventually, such an extensive megalopolis structure requires extensive capital investments to build new transport systems.
- **Cultural heritage sites and sensitive ecosystems:** Many sites of cultural and historical significance are increasingly being threatened by various types of air pollutants and the encroachment of motorized vehicles. Visitors experience is also impacted. Numerous areas of sensitive ecosystems are similarly affected by urban sprawl and the accompanying pollution.

Dense and mixed-use planning of new urban communities favors the reduction in transportation demand. This is often not the case in current new urban settlements where car-dependence is evident due to lack of planning-phase consideration of public transport, walkability, and cycling friendliness.



2 ELECTRIC VEHICLE TECHNOLOGIES

In response to the escalating environmental impact of Gasoline and Diesel-powered vehicles, the alternatives of electric vehicle (EV) technologies are rapidly proving themselves as viable cleaner alternatives. *Hybrid Electric Vehicles (HEV)* combine both the traditional Internal Combustion Engine (ICE) and an electric propulsion systems in various configurations to improve the overall fuel economy of the vehicle (e.g. Toyota Prius). The specific subcategory of *Plugin Hybrid Electric Vehicle (PHEV)* refers to hybrids that can further be plugged into an external power source for charging and not only depend on its on-board engine and generator (e.g. GM's Chevrolet Volt, Mitsubishi Outlander P-HEV, etc). The *Battery Electric Vehicle (BEV)* refers to EVs that are fully electric, and thus alternative names are 'fully-electric' or 'battery-only' electric vehicles (e.g. Nissan Leaf, Tesla Model S, etc). Various categories are similarly found in other vehicle types such as buses, trucks, motorcycles, scooters, e-bikes (hybrid electric bicycled), three-wheelers, etc, with varying degrees of success and progress.

2.1 THE TOTAL COST OF OWNERSHIP (TCO) PERSPECTIVE

EVs are generally more efficient than gasoline or diesel powered vehicles, but a major constraint in their penetration of the market is their high battery costs. Batteries constitute almost half of an electric car costs. They are however in gradual decline as battery technology improves, aiming to reach a figure seen to be an approximate threshold for price parity with the gasoline powered cars, 100 USD/kWh.

Advancements in EV penetration are still largely driven by various forms of governmental support and subsidies for manufacturers, importers, and consumers (as well as restrictions on gasoline and diesel fueled vehicles on the other hand). However, purchase price is not the suitable figure to compare costs, but rather the *Total Cost of Ownership (TCO)*. This includes cost of purchase and financing (e.g. loan or leasing), driving and associated fees and taxes, insurance, maintenance, and depreciation. In this context, there can be wide variations in the feasibility of the preference of an EV over conventional vehicles; generally high-use vehicles will become more viable from a TCO perspective. Planners and policy makers investigate the competitiveness of various vehicle types and scenarios of use in order to understand the competitiveness of EVs within the national/local context (e.g. electricity and fuel prices, maintenance costs, etc).

A key concern when purchasing EVs is its depreciation, which is the highest cost category in the TCO. Batteries degrade and they constitute almost half of the vehicle's

value, and there is much uncertainty about the deterioration of their so-called State of Health (SOH) over time. Furthermore, with such rapid development in technology, the second-hand value for EVs is very uncertain since older models can be obsolete in a matter of a few years. To overcome such risks, apart from government incentives, there is also the suitable option to lease EVs, while fleet owners can reduce risks by diversifying the vehicle types in their fleets.

2.2 EVSE AND SMART CHARGING INFRASTRUCTURE

Electric Vehicle Supply Equipment (EVSE) refers to charging stations or charge points, which charge EV batteries and commonly communicate with the vehicle to ensure an appropriate and safe flow of electricity is supplied.[11] EVSE is rapidly developing to improve charging speed and safety. Types of charging include **destination charging**, where vehicles can be left to charge for a few hours when parked at a destination (typically residential charging, work charging, and street charging), and otherwise the substantially more expensive **DC fast charging**, where vehicles need to recharge on the go, comparable to the case with refueling stations, but still requiring substantially more time. Advancements in EVSE and battery technology are proving even further reductions in charging time. Various standards are in place for various connector types and EVSE modes of operation, and various alternative technologies for charging are also under development, such as *inductive charging* whereby charging is conducted without a cable connection.

Countries striving towards 'future-proofing' infrastructure are rapidly advancing toward development of improved decentralized bi-directional **smart charging grids** (and smart grids in general). This involves various standards and **open communication protocols** to allow roaming[ii] and interoperability between public chargers, and management of billing processes as well as **managing charging time** to make best use of renewable energy (e.g. lower electricity prices in midday encourages charging when solar power is in excess) or otherwise *discharging* (selling) to the grid when necessary, among other benefits of connectivity, etc. Such possibilities facilitate reducing peak demand, optimizing grid capacity, and decarbonizing electric transport, while reducing costs for consumers.

For success of a smart charging grid, governments advocate open standards for the benefit of consumers and society as a whole. Using open standards has two key advantages: Stimulating innovation since new entrants can participate with novel solutions, and avoiding lock-in (monopoly) to ensure better competition and lower costs for consumers.

ii Similar to the concept in the Telecom industry, for EVs, 'roaming' would refer to allowing EV drivers charge their EV at charging stations that are not part of the charging network of their Charge Point Operator (CPO) using the same identification.

3 GLOBAL TRENDS AND AVAILABLE SUPPORT

The Paris agreement, enforced in 2016, set the global commitment to limit the increase of global temperature to 2°C above pre-industrial levels.[12] Given that close to a quarter of global emissions come from the transportation sector, the global community considers cleaner vehicle technologies, most prominently *Electric Vehicles* in specific, among the key areas of improvement to meet emission reduction needs.

The following highlights indicate substantial progress to date, in both developed and developing countries as assessed in key references including the 2018 Global EV Outlook of the International Energy Agency (IEA):[13,14,15]

- Global electric *car* stock passed 3 million in 2017, i.e. tripling since 2015.
- 10 countries account for 95% of electric car sales: China, USA, Japan, Canada, and six European Countries; Norway, Sweden, Netherlands, UK, France, and Germany. The most ambitious policies are set forth by China, California, and the EU, setting targets for electrification and emission standards.
- Global battery-powered electric *busses* reached 370,000 in 2017 (more than double 2015) and electric *two-wheelers* reached 250 million, but by far mostly in China (99%) despite observed penetration in Europe and India.
- Shenzhen city positions itself as a global leader in early adoption of electric buses and integration of on-demand minibus services as a last-mile solution in the transport network.
- In developing countries, there is rapid advancement in introducing electric two- and three-wheelers (tuktuks). In one prominent example, in the Philippines, a country of 3.5 million three-wheelers (offering 75% of all public transport services) is replacing 100,000 conventional three-wheelers with electric ones, 'E-trikes' with substantial support from ADB.[16]
- Private chargers at residences and work places are estimated to have reached 3 million serving households and fleets, while *publicly available* chargers (predominantly slow chargers but complemented with fast chargers) are approximately 320,000. Fast chargers are favored where long distance travel is needed or where land availability is scarce.
- Key support to encourage penetration typically include the following measures: promotion of RD&D (Research, Development and Demonstration), mandates and regulations (including technology-neutral regulations limiting CO_2 emissions), financial incentives to reduce initial costs and the Total Cost of Ownership (TCO) compared to conventional vehicles, governmental leadership through public procurement

of EVs (leading by example), and Electric Vehicle Supply Equipment (EVSE) deployment support (setting standards and regulations, etc).

- Key areas of ongoing research and development include reduction in battery costs and increasing energy density, as well as developing solutions for foreseen impact of larger EV fleets on the power grid (e.g. optimization of timing and duration of charging events, developing vehicle-to-grid solutions, etc).

- Lithium-ion (Li-ion) batteries maintain their position as the technology of choice for EVs, among the various alternatives under development. One key concern is the demand for materials for the global supply of batteries, where various social and environmental risks are associated with the demand for lithium and, to a greater extent, cobalt. This demands careful development of safeguarding regulations, and essentially from a life cycle perspective, i.e. also addressing the end-of-life stage including repurposing, recycling and disposal.

- To facilitate concerted efforts for promoting cleaner vehicles, numerous global initiatives have been launched to monitor and promote EVs. Among the leading examples are the following initiatives:

  – **EV30@30** is a campaign to achieve a collective goal of a 30% sales share for EVs by 2030 amongst all member countries of the **Electric Vehicles Initiative (EVI).**[17] The EV20@30 campaign is led by the high-level global forum, **Clean Energy Ministerial (CEM)** since its announcement in the eighth CEM in 2017.

  – **C40 Cities** is a network of megacities committed to addressing climate change. Among its prominent activities is the C40 Low Emission Vehicles (LEV) Network aiming to share best practices and policies for EVs and other LEVs.[18] Led by the city of London, the network aims to develop strategies, infrastructure, incentives, and increase market penetration of LEVs. In most recent activity, 12 mayors pledged in late 2017 to limit all their procurement of buses to only zero-emission buses by 2025, and transform a major area of their respective city to be zero-emission by 2030.[19] This will be implemented together with actions for pedestrianization, promotion of cycling, and reclaiming public spaces.[20] Earlier on, mayors of Paris and Mexico City had already pledged to ban all diesel vehicles from their cities by 2025.

  – **Global Fuel Economy Initiative (GFEI)** is a global campaign to achieve a 50% reduction in the average fuel economy of the global vehicle stock by 2050, for which EVs are seen as an important contributor to meet this goal.[21] Among the GFEI-supported studies, a baseline assessment of average fuel economy of Light Duty Vehicles (LDVs) in Egypt drew attention to the limited prospects for achieving the 2050 targets with the current business-as-usual despite slow gradual progress, thus highlighting the need for introducing electric vehicles together with ongoing efforts to renew and

improving the existing stock of ICE vehicles and introducing fuel economy labeling.[22]

- **Sustainable Urban Transport Project (SUTP)** was developed by the German Corporation for International Cooperation (GIZ) on behalf of the Federal Ministry for Economic Cooperation and Development (BMZ). It has grown since 2003 to be among the leading global initiatives for dissemination of information about international experience, policy advice, training and capacity building and targeted work on sustainable transport projects within cities. Support in promoting e-mobility has been an integral part of much of SUTP's activities within its wide scope of the *Avoid-Shift-Improve* framework.

- **Green Climate Fund (GCF)** is an operating entity of the United National Framework Convention for Climate Change (UNFCCC) to support developing countries implement adaptation and mitigation measures, with substantial support to the private sector as well. Amongst the innovative concepts notes received and praised is the proposal of concessionary green loan scheme to fund electric or hybrid vehicles and the installation of solar panels in Sri Lanka (currently in evaluation).[23] Recently (October, 2017) a Simplified Approval Process (SAP) has been adopted to catalyze proposal processes for smaller projects (requests of up to 10 MUSD) targeting projects that are ready for scaling up and having potential for transformational change towards climate resilient development.[24]

- **Climate and Clean Air Coalition (CCAC)** is a voluntary global multi-stakeholder partnership addressing Short-Lived Climate Pollutants (SLCPs)[iii] and offering support to national government agencies or local/municipal government representatives. Its secretariat is hosted by UN Environment. Among its services, the CCAC *Solutions Centre Expert Assistance* is a no-cost service that connects governments to an extensive network of professionals for consultation upon their request. Among the CCAC's various initiatives is the ***Heavy Duty Vehicles Initiative***. In this regard, CCAC is implementing the ***Soot Free Bus Fleets project,***[25] already initiating phase II. The first phase aimed to solicit government commitments to soot-free buses, while phase II targets city-level support to two selected cities that have advanced and made commitments to transition to soot-free bus fleets.[iv]

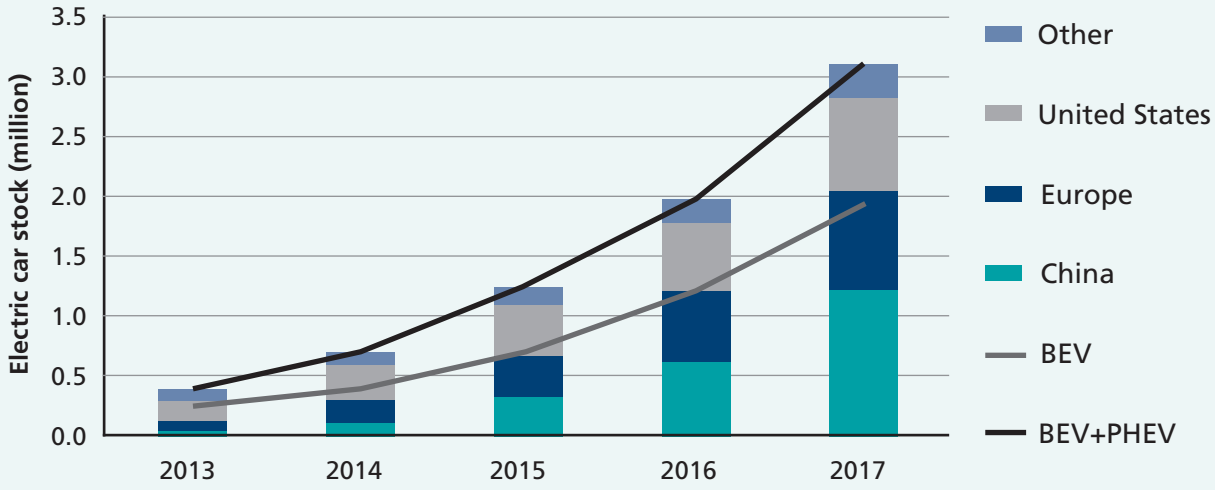
- **(New) GEF7 Global Mobility Program** is a planned global programme to promote electrification of mobility in developing countries. It shall be launched by the Global Environmental Facility (GEF) and executed by **the International**

iii Short-Lived Climate Pollutants (SLCPs) include black carbon (soot), methane, tropospheric ozone and some hydrofluorocarbons (HFCs). They can have harmful impacts on human health, agriculture and ecosystems, and they also impact current global warming in the near-time, with regional and local climate impacts.

iv Kondruchina, T. (personal communication, August 26, 2018)

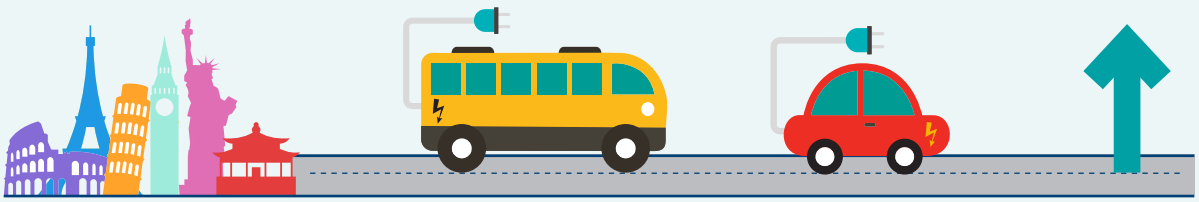
Energy Agency (IEA) with support of United Nations Environment (UNEP) and the **International Council on Clean Transportation (ICCT)** among other global and regional partners. ICCT coordinates the Electric Vehicles Initiative (EVI), and UNEP is implementing the **Emob programme** to promote e-mobility in developing countries, addressing 2&3 wheelers, electric cars, and electric busses.

Figure 5: Growth of the global electric car stock throughout 2013-2017.[13]



Notes: The electric car stock shown is primarily estimated on the basis of cumulative sales since 2005. Where available, stock numbers from official national statistics have been used (provided that the data can be shown to be consistent with sales evolutions).

Sources: IEA analysis based o country submission, complemented by ACEA (2018); EAFO (2018a).



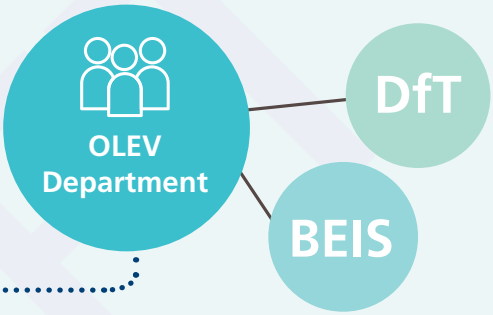
Focus in popular media tends to elaborate on electric *cars* in specific, however, in effective planning for sustainable transportation and diversification of transport modes and economizing on public space, there is growing recognition of the wider scope of EVs and EVSE. Policies and business models are therefore in continuous development to cater to electric two-wheelers (e-scooters, e-bikes, etc) and three-wheelers, buses, urban delivery vehicles, freight vehicles, and ride-sharing or car-sharing fleets. Buses and other heavy duty vehicles are of specific interest due to their large contribution to local pollution in cities.

HIGHLIGHT: UK's OFFICE FOR LOW EMISSION VEHICLES (OLEV) AND THE VISION FOR BUSES

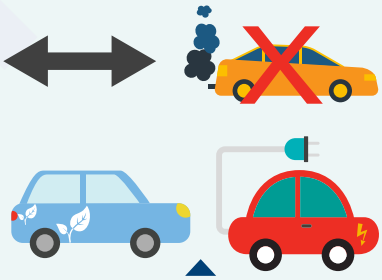
Office for Low Emission Vehicles

OLEV: The Office for Low Emission Vehicles (OLEV) is a team working across the government of the UK to support the early market for electric and other ultra-low emission vehicles (ULEV) with over £900 million dedicated to support development, manufacture and use.[26]

It consists of staff and funding from the Department for Transport (DfT), and the Department for Business, Energy and Industrial Strategy (BEIS).



VISION: The government aims to end the sale of new conventional petrol and diesel cars and vans **by 2040** and to have almost every vehicle in the country a Low or Ultra-low emission vehicle (L/ULEV)[27] **by 2050**



SUPPORT SCHEMES: Examples of support include grant programs to reduce the upfront costs of new ULEVs, programs to expand charging infrastructure such as offering matching-funding for installing charging stations in pilot areas (*e.g .Plugged-in Places* programme), support for research into next generation battery technology, among many other schemes and enabling interventions. In updated commitments, the "Road To Zero" strategy of the Department for Transport published in 2018 enlists 46 commitments to such supportive schemes and policies.[26]

Leading Example: Low-Emission Bus Scheme (LEBS) and the subsequent Ultra-Low Emission Bus Scheme (ULEBS)

£130.4 million

2016
2017

In **2016**, **DFT** and **OLEV**, through the Low Emission Bus Scheme (LEBS) supported 13 organizations with **£30.4** million mostly bus operators and local councils to buy over 300 low-emission buses and associated infrastructure.[28] Later in the same year, further **£100** million were offered in support programs, targeting the periods of **2017-2020** (£60 million for new buses and £40 million via a Clean Bus Technology Fund to support local authorities in *retrofitting* existing buses).

In **2017**, a large part of the fund was directed to a more ambitions Ultra-Low Emission Bus Scheme (ULEBS); the allocated portion (**£48** million) aims to support applicants (bidders) to buy ULEBs and associated infrastructure throughout 2018-2021. To qualify as an ultra-low emission bus, buses must produce at least **30%** less GHG emissions than a conventional Euro VI bus and meet its engine regulations. This places Electric Buses in an obvious position of advantage..

- In the ULEB Scheme, priority is given to those who demonstrate a plan to reduce dependence on the government›s subsidies over the period of the scheme and beyond, and those who demonstrate substantial reductions in emissions on a Well-to-Wheel basis.

3.1 SHARED MOBILITY

In observation of global trends, the advancements in urban mobility are shaping into three major transformational changes: Sharing, Electrification, and Automation, which have been labeled by some as the "three revolutions" in the transportation sector.[29]

Automation, mainly referring to autonomous (driverless) vehicles, is furthest away from mainstream applications in developing countries, and is associated with fears of technological unemployment. It however promises many benefits such as improved safety. Sharing and electrification on the other hand are rapidly developing and penetrating the global market in tandem, even in emerging economies.

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 (e.g. Careem, Uber, Lyft, etc) and (b) *Car-sharing*, where publicly available cars (or other vehicle types) are available for public use (e.g. Car2Go, Zipcar, etc). The terminology, definitions, and models are in continual development and vary between countries.

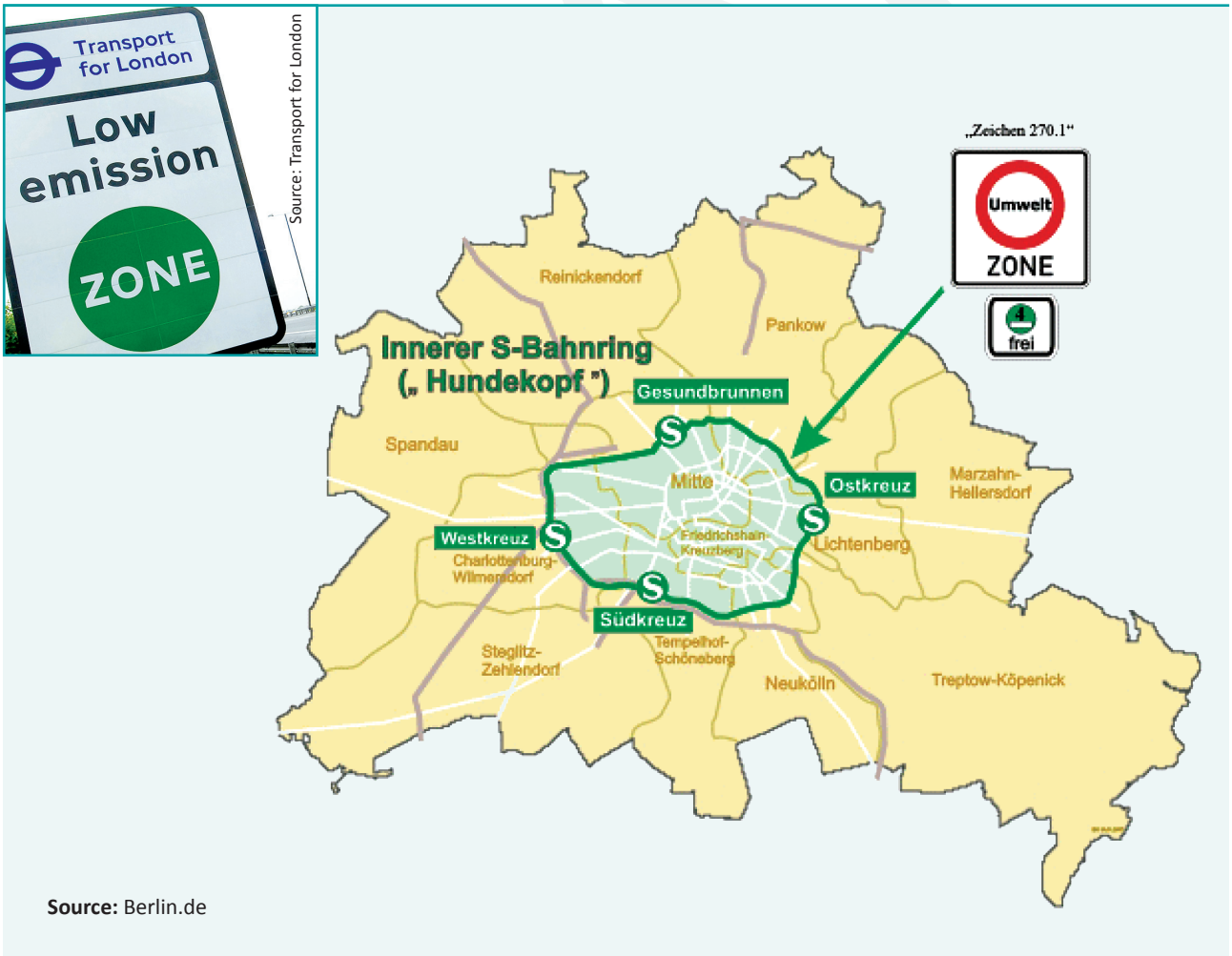
Although Electrification and sharing are not mutually dependent, they are rapidly developing *in tandem*, while even elements of autonomy are also involved. The density of cities, scarcity of public space, and increasing air pollution, are all driving innovation in mobility solutions towards lower-emission 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 LEVs in London until all its fleet in the city become hybrid or fully electric vehicles by 2020.[30,31]

3.2 LOW EMISSION ZONES AND CAR RESTRICTIONS

Within urban areas, historical sites, and near sensitive ecosystems, various regulations for limiting local air pollution can be set in place. This has been greatly facilitated by the wider availability of zero-emission vehicles along with other solutions. Examples of protecting certain designated areas vary in scope and coverage. There are city-wide applications such as central London, where a combination of congestion charging and environmental restrictions are imposed, or in various cities of Germany, including the 88km^2 *Environmental Zone* in Berlin (see Figure 6), or elsewhere in cases of smaller designated areas such as heritage sites. The Taj Mahal site in India is a famous example, where a ban has been imposed on internal combustion engine vehicles in its vicinity (within 500m), while introducing electric three-wheelers (e-tuktuks) as an alternative.[32]

Figure 6: Low emission (environmental) zones combine car restriction measures with pollution mitigation and are implemented at various scales around the world such as in London (left) and in Berlin (right).



Source: Berlin.de

HIGHLIGHT: THE JORDANIAN EXPERIENCE & LESSONS LEARNT

Since 2015, the Jordanian government took several bold steps to promote EVs and is strongly endorsed by the National Competitiveness Council that was established in the same year; a high-level council chaired by the prime minister and comprising private sector and investor representatives. Several highlights indicate the strong political will for introducing EVs:

Exemptions and incentives

Exempting Electric Cars from registration fees, which would be prohibitively expensive, as announced by the Cabinet of Ministers through a recommendation from the Minister of Finance. An exemption from custom and from sales tax is also in place, thereby limiting the expenses only to a license fee imposed for "on-road services and infrastructure".[33] The cabinet also exempted *charging devices* of fully electric vehicles from custom duties and sales taxes.[34]

Setting standards and tariffs

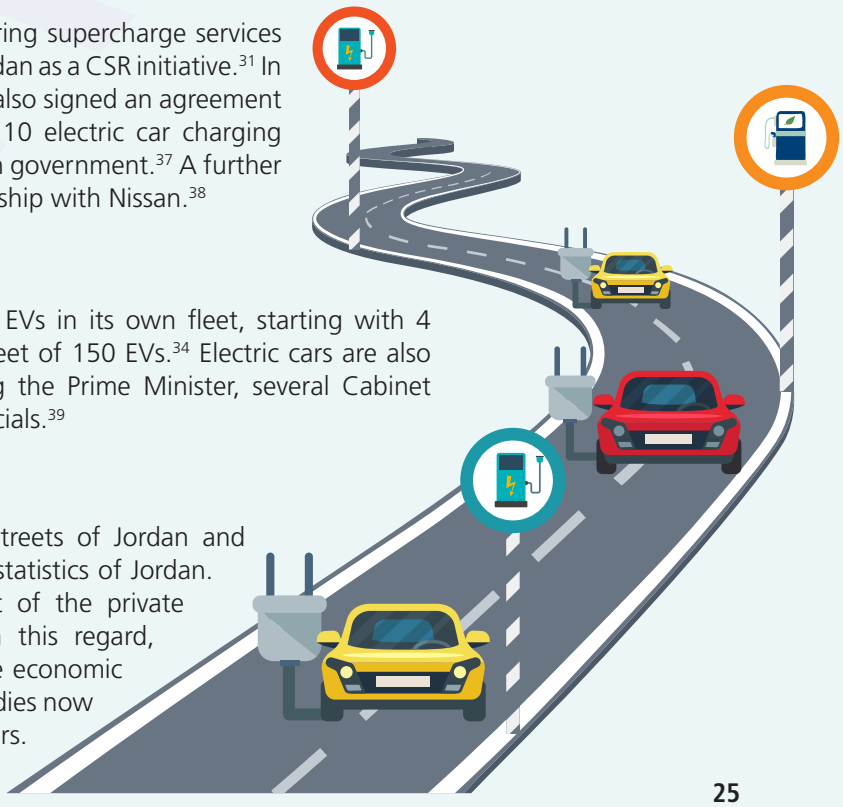
The Energy & Minerals Regulatory Commission (EMRC) issued regulations for electric vehicles charging stations; technical instructions stipulating technical, financial, and Health and Safety (H&S) aspects of EV charging activities, and setting an electricity tariff not exceeding 100 Fils/kWh (approx. 2.4 EGP/kWh).[34]

Public - Private Cooperation

During the World Economic Forum on the Middle East and North Africa (WEF-MENA) of 2015 a memorandum of understanding was signed with major manufacturers of electric cars, Tesla, BMW and Renault, to gradually adopt the use of electric vehicles in the public sector as an environmentally friendly and energy-saving means of transport.[35]

Greater Amman Municipality (GAM) also signed an agreement with Noor Jordan for Transport for the *Taxi Moumayaz* program which commits to replacing 300 cars with hybrid vehicles and up to 100 cars with electric vehicles.[36]

In support, Manaseer Group committed to offering supercharge services for electric vehicles at gas stations throughout Jordan as a CSR initiative.[31] In the same year, the Greater Amman Municipality also signed an agreement with the French Hyseo International to set up 10 electric car charging stations in Amman with the support of the French government.[37] A further set of 10 stations are being developed in partnership with Nissan.[38]



Leading by Example

Greater Amman Municipality (GAM) itself uses EVs in its own fleet, starting with 4 EVs in 2016 and aiming to reach an eventual fleet of 150 EVs.[34] Electric cars are also reportedly used by numerous officials including the Prime Minister, several Cabinet members, among other ministers and senior officials.[39]

Status today

Approx. 10,000 electric cars are now in the streets of Jordan and penetration is monitored by the department of statistics of Jordan. Among the challenges faced was involvement of the private sector in operating charging infrastructure. In this regard, the set tariffs have not been sufficient to secure economic feasibility. However, this is subject to ongoing studies now to improve the tariff structure and attract investors.

4 SITUATION ANALYSIS: EVS IN EGYPT

4.1 POLICY CONTEXT AND REGULATIONS

The key challenge to the introduction of EVs is the high initial costs of vehicles and the uncertainty of the Total Cost of Ownership (TCO) over the lifetime for the owner. The policy environment in Egypt is not yet developed to accommodate nation-wide rollout of EVs, but there are two key strengths that may provide a stepping stone for a larger framework of action; there is already custom duty exemption in place for electric cars, and secondly, with regards to institutional experience, there is an accumulation of know-how and experience in vehicle replacement programs initiated by EEAA that can be tailored to serve replacement programs for EVs, including the experience of the Micro- Small- and Medium Enterprises Development Agency (MSMEDA) in its ongoing finacial services facilitating vehicle replacement for promotion of cleaner vehicles (currently Compressed Natural Gas).

4.2 FULL IMPORT TARIFF EXEMPTION FOR ELECTRIC CARS AND IMPORT EXCEPTION FOR USED CARS

In 2013, a decree was issued by the Shura Council (consultative council) of Egypt providing electric cars with a 100% exemption from custom duties and this exemption was maintained in the recent presidential decree for import tariffs, issued on September 9th, 2018.[40] This is the main incentive in place in Egypt specifically dedicated to electric vehicles, but only specific to 'cars'. It was not part of an overall national strategy, and was not supported with plans for development of charging infrastructure or with mainstreaming into relevant laws and regulations. As an example, there is no formal process yet for licensing of electric vehicles and registering their specifications in the government's databases. Each EV purchased in Egypt is therefore licensed on a case-by-case basis through a written request to the Ministry of Interior, and it could then be assigned an engine size-equivalent (cc-equivalent) as a temporary solution for licensing and registration.

Notably however, there is no similar explicit exemption for other types of electric vehicles, such as those used for large collective transport or for electric two-wheelers.

In most recent developments, a further incentive of allowing import of used vehicles has been initiated by a decision by the Ministry of Trade and Industry to exempt electric cars from the restriction on the import of used vehicles. Otherwise, there is a general ban on the import of used cars in Egypt. With this recent exception, used electric cars now can be imported on the condition that they are no more than three years old.[41]

4.2.1 Discussing electric "Cars" vs. electric "Vehicles" at large

According to stakeholder interviews, among the controversial regulations are the custom exemptions that have been made available for *cars*, yet not for the other types of vehicles that are in more need for such incentives. As an example, fully electric buses are subject to 40% import tariffs while cars (light duty passenger vehicles) are fully exempt.[42]

Furthermore, among the challenges facing the stakeholders interviewed from both the public and private sector, is that 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. Limited awareness about the definitions and translations creates difficulty in public and private stakeholder consultations and discussions, as well as difficulty in timely operationalization of regulations. This is demonstrated in Table 1, 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).

Table 1: 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%**	٨٧.٠٢: **سيارات** معدة لنقل عشرة أشخاص أو أكثر بما فيهم السائق. • *٨٧.٠٢,٤٠: 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%**	٨٧.٠٣: **سيارات** ركوب (خاصة) وغيرها من العربات السيارة المصممة أساساً لنقل الأشخاص (عدا الداخلة فى البند ٨٧,٠٢)، بما فى ذلك سيارات "الأستيشين" وسيارات السباق. • *- ٨٧.٠٣,٨٠: سيارات أخر، مجهزة فقط بمحرك دفع كهربائى.*

4.3 POLICIES AND PROGRAMS FOR VEHICLE REPLACEMENT: TAXIS, MICROBUSES, AND 2-STROKE MOTORCYCLES

In 2008, the Ministry of Interior enacted traffic law no. 121 of 2008, which stipulates that all passenger transport vehicles (referring to taxis, buses and microbuses) exceeding 20 years of age cannot renew their license to operate. The law acted as an incentive to accelerate vehicle replacement and improve air quality, and came at a time when the automotive industry needed stimulation during the global economic crisis. In the same year, the Ministry of Foreign Trade and Industry also issued a decree banning the production and import of 2-stroke motorcycles, known for their high emissions.

In order to facilitate enforcing this provision, and to ensure that the old inefficient technology is not reused elsewhere after replacement, the Egyptian Environmental Affairs Agency (EEAA) initiated a vehicle scrapping and replacement program to incentivize taxi owners to turn in their old vehicles in return for cash and offering support to buy a new taxi with installments. During that pilot project, the new cars offered were dual-fueled, using Compressed Natural Gas (CNG) and gasoline interchangeably, while the old taxis were sent to a qualified recycling facility.[43] As a priority, the programme specifically targeted taxis exceeding 35 years of age initially, which were still in operation. Based on the pilot programme, the Ministry of Finance later adopted the scheme for wider implementation and has today replaced more than 43,000 taxis with new ones. However, in the cases of buses and microbuses, the enforcement of this law is stalled due to the associated economic constraints (limited financial resources to provide sufficient incentives) as well as concerns over the social impact on the microbus drivers that serve the majority of commuters. Activity in this respect is therefore limited to pilot projects. Currently the ministry of environment is implementing a joint project with the governorate of Cairo to replace 1000 old microbus vehicles.

Another ongoing pilot project also aims to replace the banned 2-stroke motorcycles with new 4-stroke motorcycles in another pilot project in Fayoum governorate, which targets 1000 motorcycles. Financial constraints limit the nation-wide rollout of the programs. There is also interest in exploring means to introduce EVs through scrapping and replacement programs to be initiated by the Ministry of Environment, but such ideas are still in an early phase of discussions and preliminary studies.

4.4 THE CONTROVERSIAL CASE OF THREE-WHEELERS (TUKTUKS)

Unlike other vehicles employed in transport services, tuktuks have not been subject to similar incentive schemes and are mistakenly seen by some in Egypt as only a *nuisance* rather than as a compensation for unmet transport needs. Three-wheelers are suitable in urban areas characterized by narrow streets and predominantly unpaved roads, which are

both prevalent in many areas in Egypt. They therefore **facilitate access to employment, education, medical care, leisure, and commercial activity** for a very large portion of the population. They are also a source for employment for drivers and mechanics. Their extent of coverage has further engaged ride-sharing services, who have now included access to tuktuk vehicles among their ride-share fleets.

In many uses of Tuktuks they are also employed for *collective* transport (for multiple users), and also frequently used by children in informal settlements in trips to *school*.[44] It is convenient for the narrow streets and unpaved roads in informal settlements, although also associated with various nuances (child-drivers, unsafe driving, etc) due to lack of regulations and enforcement. This mode also allows weaker and vulnerable persons (e.g. elders, disabled persons, etc) to have a convenient alternative to walking, and thereby offering an important empowerment function for various marginalized segments of society.

In one project by the UN Population Fund (UNFPA) together with the Ministry of Health of Egypt, the use of the tuktuk highlighted it's fundamental role in access to medical care, as well as noting gender implications. The use of three-wheelers was central to a programme implemented to reduce infant mortality in poor areas in Upper Egypt. It involved training midwives to provide professional assistance to women in labor in disadvantaged areas while facilitating the mobility of midwives to access the difficult-to-reach areas on time using the tuktuk.[45]

However, despite their importance, there is much uncertainty about their numbers and a lack of monitoring and enforcement of standards for their operation. Although latest statistics indicate approx. 99,000 *licensed* tuktuks in Egypt,[46] the actual number is unknown, and often estimated by relevant authorities to be in a more likely range of two million or more.

The Ministry of Environment, maintains the position that three-wheelers are one of the valuable areas for demonstrational intervention for deployment of EVs as an approach to combine ongoing formalization efforts together with vehicle fleet renewal efforts, while addressing the air pollution impact noted in their informal stations.

4.5 STATUS OF EV RECOGNITION AND MAINSTREAMING

There are clear indicators of interest in exploring introduction of EVs among public authorities. This is evident in announcements in the media and in commissioned exploratory studies, and culminating in a recent agreement by the Alexandria Passenger Transport Authority (APTA) to purchase 15 electric busses. Elsewhere, the deployment of demonstrational charging stations in Cairo is also in progress, although in very early exploratory stages. The breadth of the issues to tackle however are very wide (standards, regulations, infrastructure, parking policies, tariffs, market segmentation, etc), making it challenging for planners to decide on where to start.

There is therefore a substantial need for capacity development amongst stakeholders as well as a need for continual exchange of information and experience both within Egypt and internationally to cope with this rapidly developing field, in parallel to the gradual consolidation of the ad hoc activities that cater to the deployment and mainstreaming of EVs.

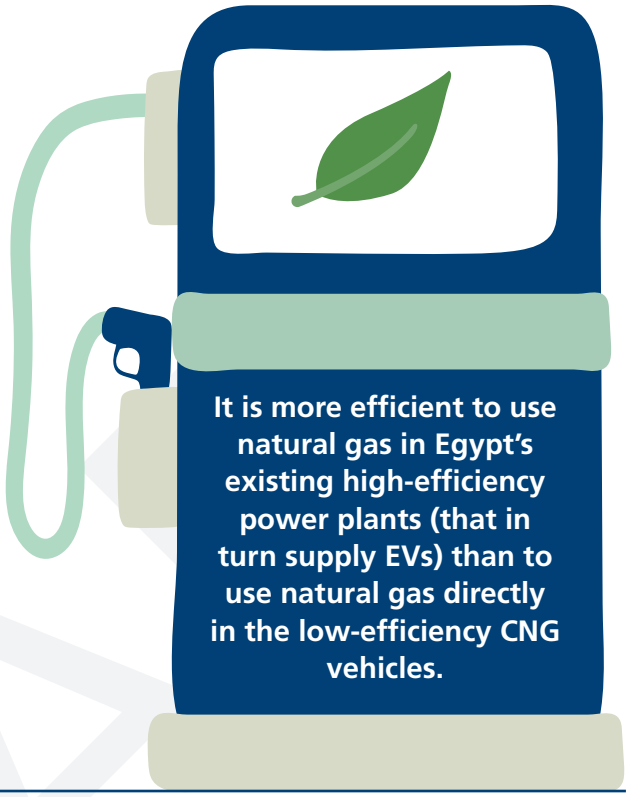
With regards to the *language* barrier, due to the rapidly evolving nature of new technologies, educational modules are needed (e.g. special courses, workshops, online courses, awareness programs etc), but such content is mainly available in English. Arabization of (regularly-updated) educational content is scarce. This further challenges the dissemination of information and updates about EV technologies and related topics about policies and regulations, etc, and limits its dissemination throughout public authorities, universities, and popular media.

Figure 7: Progressive e-mobility developments by Alexandria Passenger Transport Authority (APTA)

Furthermore, the government recognizes the opportunity to deploy charging infrastructure in new cities. Most interest is in the new administrative capital under development as well as throughout the expanding intercity road network in Egypt.

4.6 NATURAL GAS ON THE HORIZON

There have been commendable programs in the past to introduce Compressed Natural Gas (CNG) in taxis and busses in Egypt, along with successful investments in the necessary infrastructure. In the meantime, recent discoveries in the Mediterranean sea promise an abundance of cheap natural gas in the coming decades. Accordingly, a common question associated with e-mobility in Egypt (noted throughout stakeholders consultations) is whether Egypt should rather move towards further expansion of CNG use in transport to reduce pollution if it will be cheap and abundant. This highlights the need for awareness raising about the conceptual understanding of e-mobility, and the following rule-of-thumb is recommended to guide further detailed discussions:



Furthermore, although natural gas reduces local air pollution compared to diesel powered vehicles, it is nevertheless a significant source of local pollutants.

Prospects for the overall power grid emissions per unit of electric energy are also moving towards cleaner levels not only because of the improved efficiency of new power plants in the pipeline, but also the planned expansions in new and renewable energy.

4.7 HISTORICAL SITES AND SENSITIVE ECOSYSTEMS

Pollution has significantly affected the surfaces of the Pyramids of Egypt and other historical monuments, and has been one of the reasons for the relocation of the Ramses II statue from one of the most congested areas in Egypt in 2006. Similarly so, numerous areas of sensitive ecosystems are close to vehicle traffic and impacted by air and noise pollution (e.g. bird migration routes and breeding sites, etc) threatening Egypt's biodiversity, including threats to the aquatic environment and estuarial zones. Most of Egypt's towns and cities are along the Nile river, its delta, and elsewhere along coastal zones that may be affected in terms of noise and air pollution by nearby traffic or on-site vehicles, whether road vehicles or boats.

Figure 8: Air pollution among the drivers of the historical 2006 relocation of Ramses II

Policies to reduce congestion, promote pedestrianization, and reduce local air pollution in historical and cultural heritage sites have for long been discussed amongst planning authorities in Egypt, with some precedents of trials to promote e-mobility in historical sites in Cairo[47] and in Luxor.[48] These initiatives however have not been part of an integrated sustainable mobility plan and are rarely monitored and evaluated, and are not explicitly associated with measures for emission reduction or restriction of high-emission vehicles. This highlights an opportunity for substantial improvement in planning processes to leverage such existing interest and political will.

4.7.1 Lessons learned

In past experience of introducing Electric Buses, a project was launched in Egypt in 2000 to introduce electric and hybrid-electric buses with assistance from United Nations Development Program (UNDP) and financial support from the Global Environmental Facility (GEF). The executing agency was EEAA and the first phase included introducing two buses along with their supplies and necessary capacity building for operation and maintenance. Ownership was later handed over to the Supreme Council of Antiquities (SCA). In trials, SCA moved the first bus from the initial zone of the Giza pyramids plateau to the zone around Hatshepsut Temple for operation on flatter topography, more suitable for the technology at that time.

The program was originally intended to eventually rollout a large fleet together with its charging infrastructure and to further explore local production opportunities. The program however was discontinued after the trial due a combination of factors, including several hurdles and delays in implementation along with the changing priorities of the GEF approach to funding sustainable transport projects; funding priority shifted from promoting alternative technology to focus on transport planning and non-motorized transport.[49] However, several lessons learnt were gained from the brief pilot experience.

Among the difficulties faced were substantial delays in completing contracts and paperwork (it was not clear if the equipment should be exempted from custom duties). Shortly after arrival of the first bus, it was stored in the free trade area for a couple of months, and a similar process with the second bus also caused delays and costly storage charges. The buses had also been delayed in the country of origin (USA) due to such administrative difficulties, which caused damage to the battery packs and dust settling in the vehicle parts causing later overheating during operation. Other delays where coincidental, they were associated with lack of communication for 8 months after the 9/11 attacks, also leading to delayed maintenance and consequent damages.

However, the buses, which have been in operation for several years can be seen as a proof-of-concept. The key lesson learnt was that the operation of buses should be handed over to an entity such as SCA, which cannot function as a fleet operator. It is recommended that operation should be outsourced to competent private sector operators, e.g. as concessions for operation and maintenance in service areas. Furthermore, exploring alternative means of sustainably financing such projects are necessary, other than grant programs. This might be possible today after 18 years of technology development, cost reductions, and availability of various existing and emerging funding solutions.

4.8 PRIVATE SECTOR ENGAGEMENT

Although national strategy for e-mobility is not yet set in place, there is growing pressure and interest from private sector players. A leading Chinese manufacturer (BYD) are launching Egypt's first full-electric public transport bus in Alexandria, while elsewhere multiple auto dealers and other private sector players are advocating governmental support to introduce electric cars. Other private sector operators of public bus fleets are also investigating opportunities for introducing EVs in their bus fleets in cooperation with leading players in the field, including plans for after-sales services and capacity building for operation and maintenance. However, through their feasibility studies, it is evident that further support is needed to facilitate the financing of such projects as practiced in other countries incentivizing electrification in public transport (e.g. China, UK, etc).

In an early advancement in this respect in Cairo, an emerging Egyptian start-up company, Revolta Egypt, has established notable presence in the media in recognition of its attempts to market electric cars and deploy promotional stand-alone charging stations. It has recently been receiving attention from public authorities as well.[50] In 2017, it managed to establish cooperation

with state-owned fuel distribution company Wataneya to install EV charging stations at their gas stations. The first station of such has been launched in February 2018, while previous demonstrational charging stations have also been tested at limited work places and shopping malls. Following a *learning-by-doing* approach they envision deployment of 65 charging stations, reportedly including fast chargers on highways as a first stage of development. Key challenges have been the lack of accompanying regulatory and administrative considerations to facilitate EV ownership and licensing.

Another notable player is an entrepreneurial initiative (Mashroey) within Ghabbour Automotive Group, a leading Egyptian vehicle manufacturer, through which hybrid electric bicycles, *e-bikes*, have been widely marketed. It has been active since February, 2016, with sales amounting to 585 units in their early 10 months of introducing the product. Market penetration was initially established with an initial low-pricing incentive. Payment through installments are also provided through a microfinance facility to allow wider social inclusiveness. Future prospects include introduction of electric motorcycles and scooters as well as electric three-wheelers (e-tuktuks), which are at various phases of their current project pipelines, yet pending necessary governmental (non-financial) support. Challenges in progress include regulatory uncertainty and administrative challenges given the novelty of the products and unclear unified definitions, standards, and procedures governing EVs.

In most recent developments, an emerging player is Darshal Egypt, the sole agent for China's Dongfeng automobile company who is initiating a strategic movement toward local assembly of electric cars and charging stations in Egypt, while lining up further partnerships for distribution, after-sales services, and expansion, including prospects to manufacture batteries and spare parts locally.[51] A launching event to announce initial plans was held in July 2018 showcasing the fully electric microbus (DFLZ M5) to be produced in Egypt in the production lines of SMG Engineering Automotive Co., which received wide media coverage and political support.

4.9 KEY STAKEHOLDERS

The key stakeholder responsible for introduction of EVs in Egypt as *climate action* is the Ministry of Environment in its role through its executive arm, the Egyptian Environmental Affairs Agency (EEAA) as a coordinating body and potential host for demonstrational programs. Such ownership of the mandate however, has not been concluded to date. Variation in ownership can vary depending on the national agenda, whether interest is in framing E-mobility to be primarily associated with climate and air pollution as presented herein, or otherwise primarily associated with industrial development, or sustainable cities, sustainable transportation, or smart grid development, etc.

Coordination would consequently be ensured with the Ministry of Electricity as the provider of electricity (and its affiliated New and Renewable Energy Authority), the Ministry of Interior for vehicle licensing and registration, the Ministry of Finance and its subsidiary Customs Authority for regulating custom duties, the Ministry of Trade and Industry for setting standards and overseeing specifications and permits for EVs and EVSE imports (and potential manufacturing),

through its subsidiary General Authority for Export and Import Control (GOEIC) and the Egyptian Organization for Standardization (EOS), and the Ministry of Housing (and its affiliated New Urban Communities Authority) for sustainable urban planning.

Within the Ministry of Transport, the Greater Cairo Transport Authority (GCTRA), under the Ministry of Transport, is responsible for regulation and planning, while operating bodies are in place to operate public transport vehicle fleets at the governorate level in the major cities: The Cairo Transport Authority (CTA), in Greater Cairo, and Alexandria Passenger Transportation Authority (APTA), in Alexandria.

Furthermore, for new cities, there are authorities that may introduce transformational change as part of their mandates of developing new urban settlements: The (and its affiliated New Urban Communities Authority) aforementioned New Urban Communities Authority (NUCA), and the National Projects Department of the Ministry of Defense overseeing Egypt's new administrative capital being developed East of Cairo.

Other key influencers include associations of the automotive industry, most prominently the Automotive Marketing Information Council (AMIC), the Egyptian Automobiles Manufacturers Association (EAMA), the Egyptian Automobiles Feeders Association (EAFA), and the Federation of Egyptian Industries (FEI) (specifically, the transport branch of its Engineering Chamber). These are the stakeholders that voice the concerns and aspirations of the automotive sector, pursuing growth, job creation, and expanding local production.

4.10 CHALLENGES AND OPPORTUNITIES

There are several opportunities in Egypt that support the widespread deployment of EVs:

1. **Urban density:** The nature of the urban environment in Egyptian cities is characterized by high density, which favors use of EVs and reduces necessary investment costs in infrastructure and space requirements for gas stations.
2. **High stop-and-go city traffic:** The nature of the slow and frequent stop-and-go driving in Egyptian cities, which is associated with congestion and urban density, further increases the relative benefits of EV use compared to conventional vehicles in this scenario compared to other settings with smoother driving cycles and high use of highways.
3. **Low grid emission factor with introduction of nuclear power, Combined Cycle Gas Turbine (CCGT) power plants, and expansion in renewables:** The power grid is foreseen to have a lower emission factor over time (average emissions per kWh of electricity) with the foreseen expansion in renewable energy and nuclear power, as well as higher efficiency CCGT plants, thus promising an even higher relative reduction of emissions due to EV-use compared to conventional vehicles or to carbon-intensive power sectors elsewhere.
4. **Interest from public and private sector:** There are already commendable ad hoc initiatives and interventions in place that can be coordinated and leveraged:

- The public authorities engagement indicated in the active custom duty exemption for electric cars, the recognition of EVs in the upcoming new traffic law, age limits on old public transport vehicles to encourage fleet renewal, and the recent landmark agreement for the purchase of E-buses in Alexandria.
- The private sector engagement indicated in the initial sales of several electric cars and numerous e-bikes to early-adopters, as well as advocacy for improved regulations and recognition, and the recent installation of demonstrational charging stations.

5. **Institutional experience in relevant incentive schemes:** Various schemes for vehicle scrapping and replacement (CNG taxis, CNG buses, and four-stroke motorcycles) are already in place, indicating suitable institutional experience and familiarity with such programs and incentive schemes.

6. **Political will to support solutions for diesel consumption:** The government is prioritizing reduction in diesel fuel consumption in specific as a pressing matter, both from a financial point of view (due to high import-dependence compared to gasoline) and an environmental and public-health point of view (due to hazardous levels of Sulfur content) as well as the ensued impact on vehicle performance and efficiency.

On the other hand, the key challenges to initiate the sector in Egypt are associated with the delay in developing the enabling policy environment and regulatory framework, albeit in progress, along with limited financial resources as well as other competing priorities in the national development agenda.

Furthermore, the are various usual barriers associated with new technologies prevalent, such as uncertainty about technical and financial feasibility, necessary legal and regulatory prerequisites, market response, impact on employment and on the local industry, etc. There are also several technology-specific challenges. In the case of EV deployment, these uncertainties about impact on the power grid (in the case of high-penetration scenarios), implications for urban planning and understanding means to cater to apartment dwellers (given the lack of off-street parking in Egypt), uncertainty about battery life and performance in hot climates, etc.

Data availability for fuels and vehicles are also a key challenge. A major blind-spot in planning for cleaner vehicles is the stock dedicated to informal transport use, such as tuktuks and 9-seat buses (vehicle types and numbers, routes, fuel consumption, job opportunities and social aspects, etc), which requires dedicated baseline studies to inform policy makers and planners.[52] This would also facilitate the transition toward formalization of the sector.

To address the various challenges, it is notable that novel technologies of similar nature have often been initiated in the past in Egypt with support of international development organizations to support this initial phase of penetration and to provide experience exchange. Examples in the past include the introduction of LED lighting, solar and wind power, and CNG powered vehicles. This approach of support, in light of the current stage of development, is favorable and necessary (i.e. preliminary studies, capacity building, demonstrational projects, facilitating access to funding, etc) in tandem with guidance in developing the legal and regulatory requirements needed and feasibility studies for various interventions.

5 RECOMMENDATIONS

The recommendations herein are in alignment with an overall long term vision to deploy and mainstream EVs in Egypt in terms of market penetration as well as eventual local production for the purposes of enhanced economic development and competitiveness, environmental sustainability, savings in energy and fuel costs, and integration into the wider scope of sustainable mobility and livable cities.

In this respect, the recommended priorities are as follows:

- Prioritizing **high-usage, high-occupancy vehicles** in order to maximize relative benefits (taxis, buses, microbuses, tuktuks, ride-share and car-share fleets, company fleets, etc), with higher priority to diesel-powered vehicles (however, low-usage private cars are nevertheless also important for the purposes of branding and trend-setting).
- Targeting **vehicle scrapping and replacement** approaches rather than merely market penetration of EVs in order to accelerate the improvement of the average fuel economy and emissions of the overall vehicle stock, curb congestion, and stimulate the automotive sector. Parallel establishment of **fuel economy labeling** for cars is recommended to promote awareness and facilitate efficiency-based incentive policies[22].
- Integration of EV promotional schemes into the bigger picture of sustainable mobility projects and solutions and **not as a separate intervention**, i.e. integration into the wider mix of solutions including promotion of public transport and multi-modal transport, car-sharing and ride-sharing, inter-modal integration, etc.
- Establishing the enabling environment for EVs, comprising suitable policy and regulatory interventions:
  - Expanding the existing incentive of **custom duty exemption**, to not only target **'motor cars'** but also all vehicle types ('**motor vehicles**') and charging equipment as well (so as to include E-buses of various sizes, electric two-wheelers and three-wheelers, etc, as well as charging stations) similar to promotional considerations made for renewable energy.
  - Establishing standards and procedures for licensing and registration of EVs of various vehicle types and integration into the upcoming drafting of **the executive regulations of the new traffic law** under revision.
  - Including EVs as recognized sustainable products advisable in Egypt's **Sustainable Public Procurement (SPP) policies** in alignment with the guidance document for Egypt's Sustainable Public Procurement developed in reference to Law 89/1998 for tenders and auctions.

  - Setting the **tariff scheme** for vehicle charging and incentives.
  - Commit to the **conversion of historical sites and other environmentally sensitive zones into Low-Emission Zones (LEZs),** in combination with pedestrianization plans.

- Continuing support to **demonstrational projects and interventions** but ensuring **monitoring and evaluation** of results in order to ensure accumulation of experience.
- Furthermore, enhancing, consolidating, and *marketing* the **government's indicators of commitment** in terms of various policies and regulations in place or in preparation, as well as infrastructure plans, which will **encourage private sector engagement**, local production, and attract foreign investment as well as encourage multilateral development banks (MDBs) and other international development organizations and environmental/climate funds and facilities, that would support the development of the EV market and industry.
- Together with the policy recommendations, next steps in terms of studies should be the development of a **baseline assessment** to enable monitoring, evaluation and reporting of any implemented interventions, and to provide basis for objective planning and modeling, such as in modeling the future impact on the power grid, or developing scenarios for nation-wide fuel and emission reductions. This demands **improved data collection and sharing** as well as **harmonizing nomenclature/definitions between public authorities**. This *ongoing* effort would likewise facilitate Egypt's UNFCCC reporting commitments as well, namely the biennial update reports and national communications.
- In parallel, in order for stakeholders to appreciate the complexity and diversity of the topics that underlie EV deployment, it is imperative to provide extensive **capacity building** and awareness programs (including production of **Arabic content**) as well as **experience-exchange** programs with countries/cities of various levels of development.

Finally, in order to facilitate the understanding and appreciation of the diversity of initiatives to support deployment and mainstreaming of EVs in Egypt, a collection of suggested interventions are enlisted in Table-1 developed in consultation with key stakeholders (for indicative purposes).

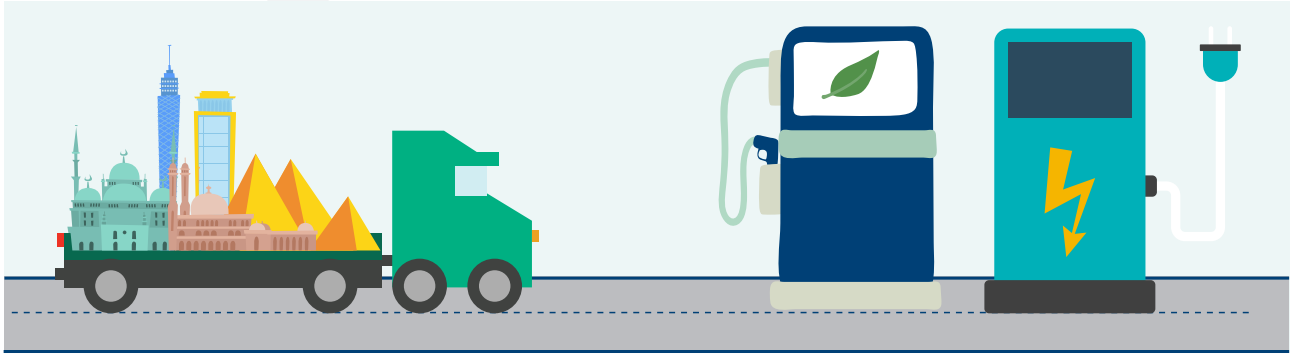


Table 2: Proposed (indicative) interventions developed through stakeholders consultationsv

PROPOSED INTERVENTION	RATIONALE	CURRENT STATUS
POLICIES AND REGULATION		
EV Recognition: Defining and mainstreaming EV type(s) into traffic and vehicle regulations: • Integration EV categories into Ministry of Interior databases and public statistics. • Integration into Traffic Law amendments (Executive Regulations). • Development of procedures for licensing and registration of E-vehicles (clear streamlined one-stop procedures). • Recognition of EVs as an environmentally-friendly technology and of national interest (such as done with solar power equipment). Key stakeholders: Ministry of Interior.	• Removing/reducing administrative barriers for purchasing and operating EVs. • Demonstrating government's endorsement of EVs to encourage private sector engagement.	• There have been a few vehicles licensed, but only through a case-by-case lengthy request-and-follow-up process, with conversion of specifications to the ICE vehicle equivalent units. • Government unclear on whether EVs shall be viewed as mainly luxury products or clean-technology products, or otherwise subject to segmentation and categorization. Bicycles for example, are subject to high custom duties despite being promoted as an environmental and a fuel-saving vehicle.
Standard-setting: 1. EVs of various types, 2. Batteries, 3. Charging equipment and infrastructure (Electric Vehicle Supply Equipment [EVSE]) Key stakeholders: Egyptian Organization for Standardization (EOS).	• This is to ensure that the first wave of EV penetration does not harm confidence in the technology in the new market (one of the lessons learnt from the history of introducing efficient lighting in Egypt). • EVSE standards shall ensure quality, interoperability, and compliance with regulations (including building codes) and permits.	• There are no fuel economy labeling standards set in place for ICE vehicles although for available for some vehicle components (e.g. tires) and soon for fuels (in progress). • With regards to efforts for standardization, in light of limited resources, there is currently less priority to establish standards for new cars and more priority for setting standards for *fuel quality* since it is a greater cause of pollution from on-road vehicles.

v Indicative interventions enlisted herein are based on stakeholders consultations, expert opinions, and reference to international experiences, but not yet based on necessary detailed studies such as cost-benefit assessments and policy impact studies. The table is therefore provided for indicative purposes.

PROPOSED INTERVENTION	RATIONALE	CURRENT STATUS
POLICIES AND REGULATION (continued...)		
Incentives program (developing a mix of incentives, including protection of *existing* incentives): • Maintaining the existing customs exemption for electric cars and expanding it to include *E-vehicles* of all categories, batteries, and charging stations. • Provision of a promotional period of free charging for early adopters, and other incentives to reduce costs of ownership (e.g. tollgate fee exemptions, parking privileges, etc). • Enforcement of a nation-wide energy efficiency labeling scheme for cars to facilitate monitoring and evaluation, ensure customer awareness, and facilitate launching of targeted incentive programs such as feebate systems (fees for polluters and rebates for clean technology). Key stakeholders: EEAA as a coordinating entity, and primarily involving the Ministry of Trade and Industry, Ministry of Transport, Ministry of Electricity, Ministry of Defense, Ministry of Finance (Customs Authority).	• Diversifying the options for cleaner vehicle technologies. • Stimulating demand for EVs and creating a market to (a) expand usage, and (b) eventually justify and encourage local production as the market matures.	• Custom duties exemption already in place but only for Electric *Cars*. • One private company initiated demonstrational charging stations offering free charging and another company is emerging in this market, but institutionalization of the scheme has not yet been discussed among the competent authorities for expansion into a wider program (planned organizational structure for charging operations and necessary communication protocols, etc). • Eco-labeling (for energy efficiency/ fuel economy / carbon emissions) is not in place for regular ICE vehicles, however, past experience of energy efficiency labeling is available through the nation-wide labeling scheme in place for home appliances.

PROPOSED INTERVENTION	RATIONALE	CURRENT STATUS
PILOT PROJECTS		
Electric three-wheeler (tuktuk) pilot program: Replacement of aging gasoline-powered tuktuks with E-tuktuks for passenger transport in informal settlements, or alternatively historical sites and protectorates.	• Fuel savings and emission reductions. • Improved Quality of Service (QOS) for passengers. • Reduced operation costs for owner. • Proof-of-concept for feasibility of high-mileage EVs. • Possibility to integrate vehicle tracking for improved fleet management (and contribution to mapping and data collection efforts). • In the case of tuktuks: Reduction in local air and noise pollution in the congested *informal stations*, near and inside informal settlements. • In the case of buses: Reduction of diesel fuel consumption (and subsidy expenses) along with reduction of its specifically high emissions of SOx, and PM2.5.	• Expressed interest from the Ministry of Environment to initiate studies on this specific service. • Candidate stakeholders from the private sector interested but fear unclear regulations that recognize the vehicle type of e-tuktuks (customs, licensing, etc).
Electric micro-buses and public buses Pilot Program: Replacement of aging buses and microbuses and scrapping old vehicles (or re-assigning old vehicles to less congested regions). An alternative to 'replacement' is 'introduction' in the case of new cities or fleet enhancements.		• Study commissioned by the Ministry of Environment (Mowafi, 2016) recommends pilot introduction of E-busses. Similar prior studies of NGMC (2002)[53] and El-Mergawy (2015)[54] also conclude context-specific competitiveness of high-mileage buses compared to diesel buses. All three studies refer to battery electric buses (full electric). • A pilot program for renewing (scrapping and replacement) of diesel-powered microbuses is in place, but financial resources for expanding the program are not currently foreseeable. Inclusion of electric buses has not been considered due to the high initial cost. • Key challenge for microbus replacement is mitigating potential social impacts, which requires sufficient cash incentives for drivers and support in operation. • Alexandria governorate recently announced purchasing 15 BYD K9 12-meter all-electric buses and 18 charging points, launching the first bus in June 2018.
Taxi Replacement Pilot Program: Replacement of aging taxi vehicles with new e-vehicles through integration with existing replacement program.		• Experience already accumulated in taxi scrapping and replacement programs, but replacement with e-cars not discussed to date, and no respective studies planned yet.

PROPOSED INTERVENTION	RATIONALE	CURRENT STATUS
PILOT PROJECTS (continued...)		
Ride-sharing vehicle fleets demonstrational program: Integration of e-vehicles into fleets of ride-sharing businesses in Egypt (Uber, Careem, Halan, etc).	• The use of car-sharing and ride-sharing facilitates the education of a larger audience (individual passengers) about EVs.	• Although integration of EVs practiced in car-sharing marketing programs abroad (e.g. Dubai, London, India, etc), it has not been discussed to date in Egypt. However, the culture of ride-sharing is prevalent and growing to become a large contributor to gasoline consumption. • According to stakeholder consultations, EV integration can be considered by transport network companies if a significant fleet can be secured (e.g. 50-100 electric-cars) within a viable geographic area and access to charging infrastructure.
Car-sharing fleets demonstrational programme: Introduction of a pilot scheme for car-sharing.	• Stimulating the culture of shared-use of resources (sharing economy) in the field of transport, and reduction in the ownership-culture (targeting the younger generation), with long term benefits of reduced emissions and saving public space that is lost to the increasing footprint of car parking.	• There are currently no car sharing cases in Egypt. The closest relevant experience is E-bike sharing schemes implemented in limited locations of closed urban communities (e.g. El-Gouna, SODIC developments, etc), but not yet conducted in the public street network. • A potential area of interest is in the new administrative capital, for which the relevant authorities have expressed interest and are welcoming any studies on the topic.
Infrastructure provision: Establishing a demonstrational network of public (non-residential) charging stations.	• Catering to potential demand, and establishing standards, regulations, and testing payment methods/ incentives.	• A national strategy is not yet in place. • The main existing activity in this respect is through a private sector actor that is incentivizing the rollout of charging infrastructure in Egypt with both destination charging (e.g. commercial buildings), with own charging cards that they are piloting for promotional purposes, as well as other industrial actors aiming to initiate local production or in the process of actual production.

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