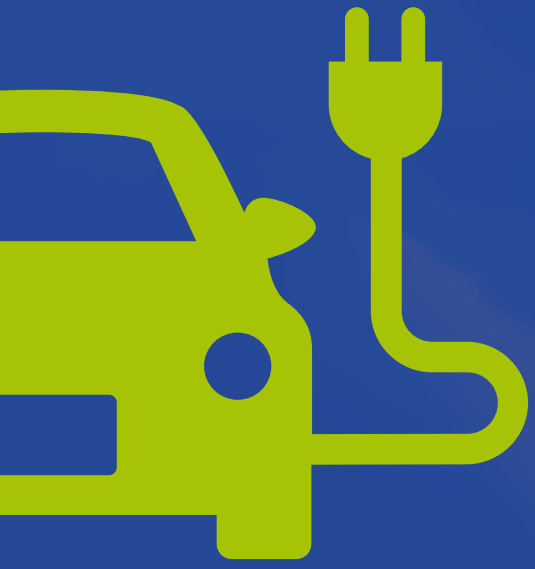

ELECTRIC MOBILITY IN KENYA

THE FACTS

REPUBLIC OF KENYA

MINISTRY OF TRANSPORT, INFRASTRUCTURE, HOUSING, URBAN DEVELOPMENT & PUBLIC WORKS

STATE DEPARTMENT FOR TRANSPORT

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

On behalf of

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

of the Federal Republic of Germany

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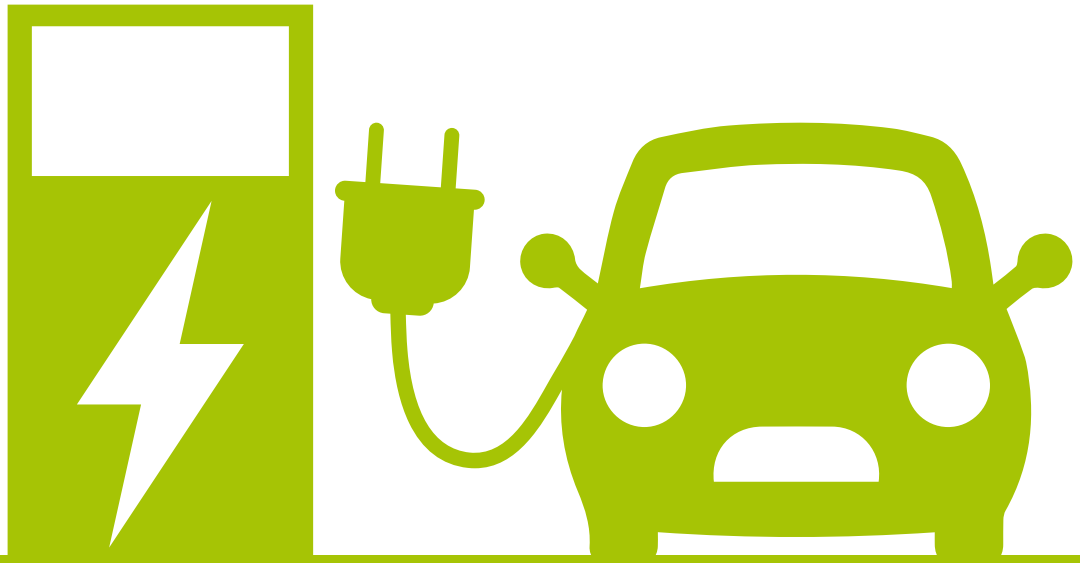
Contents

Abbreviations

AC	Alternating Current
BEV	Battery Electric Vehicle
BRT	Bus Rapid Transit
DC	Direct Current
EOL	End-Of-Life
EV	Electric Vehicles
EVSE	Electric Vehicle Supply Equipment
GHG	Greenhouse Gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
HEV	Hybrid Electric Vehicle
ICE	Internal Combustion Engine
ICT	Information and Communications Technology
IKI	The International Climate Initiative
kWh	Kilowatt hour
LRRT	Light Rail Rapid Transit
$MtCO_2e$	Million tons of carbon dioxide equivalent
NCCAP	National Climate Change Action Plan
NMT	Non-Motorised Transport
PHEV	Plug-in Hybrid Electric Vehicles
SDG	Sustainable Development Goals
SDoT	State Department of Transport
SGR	Standard Gauge Railway
TraCS	Advancing Transport Climate Strategies Project

1 Why is everyone talking about electric mobility?

The transport industry is growing rapidly in Kenya as it is globally. The government has undertaken large infrastructural developments to strengthen the country's position as the leading regional transport and development hub for East Africa. This has seen a significant growth in the vehicle fleet in the country with the current vehicle population standing at over 2.5 million and the average number of newly registered units exceeding 200,000 annually since 2014[1]. While supporting economic growth and social connectivity, the present transport scenario also brings about many problems such as air and noise pollution, congestion, increased demand for petroleum imports and consequent greenhouse gas (GHG) emissions.



According to the Traffic Index 2019, Nairobi is ranked the worst city in Africa and fourth in the world on overall inefficiencies in its traffic system[2]. These traffic snarl-ups and congestion cost the economy 50 million shillings in lost productivity every day[3] and has contributed to respiratory diseases being the leading cause of morbidity at 39% of the total disease incidences in 2018[4]. The transport sector directly accounts for about 13% of the country's total emissions from transport and growing faster than in any other sector[5]. Increased GHG emissions causes global warming leading to extreme climate events.

Kenya is already grappling with its share of the effects of climate change with increased frequency and intensity of extreme weather events, such as droughts and floods hitting many regions across the country. The destruction of infrastructure has also negatively affected the energy, transport, housing, communications, manufacturing and tourism industries amounting to billions in losses. As part of the efforts to create a sustainable transport system and achieve the country's targets in the National Climate Change Action Plan (NCCAP), the government has laid out plans for a Bus Rapid Transit (BRT), Light Rail Rapid Transit (LRRT) systems, extension of the Standard Gauge Railway (SGR) and promotion of Non-Motorised Transport (NMT) such as walking and cycling. Significant emphasis is also being put on electrification of the vehicle fleet in the country. It is crucial for us to find ways to provide mobility with minimal footprint on the environment.

Is it possible to establish a clean, efficient and safe transport system to safeguard an eco-friendly future?

One solution is electric mobility. Electric mobility also known as e-mobility is the use of electricity to power the transport infrastructure as an alternative to fossil fuels. This electricity is preferably from renewable energy sources such as hydro, geothermal, wind and solar to minimise overall emissions. Kenya's energy mix is very favourable to support e-mobility with nearly 85% of our energy coming from renewables. This is a great opportunity for Kenya.

What this brochure is about

This brochure answers to frequently asked questions about electric mobility and addresses the doubts and fears surrounding the viability of electric mobility in the country. It is informed by research from government reports, scientific studies, expert opinions and case studies to promote the uptake of e-mobility for both the private and public transport sectors.

2 What is electric mobility all about?

Electric mobility (E-mobility) refers to the use of Electric Vehicles (EVs) for mobility backed up by a robust information and communications technology (ICT) infrastructure. Electric vehicles are propelled by one or more electric motors powered by rechargeable battery packs in place of an internal combustion engine (ICE). EVs are emission-free in use, less noisy and more efficient in energy input than conventional vehicles (cf. Figure 1).

Electric mobility encompasses all the different types of vehicles: cars, motorcycles, bicycles, 2- and 3-wheelers, buses, boats and electrified rail.

Electric cars are classified into four categories according to the use of electricity as the primary fuel or in part to improve the efficiency of conventional vehicle designs (cf. Figure 1).

Figure 1. Electric Vehicles Categories

Categories	**Battery Electric Vehicles**	**Hybrid Electric Vehicles**	**Plug in Hybrid Electric vehicles**	**Fuel Cell Vehicles**
Description	BEVs use batteries to store the electric energy that powers the motor. The EV batteries are charged by plugging the vehicle in to an external electric power source.	HEVs are powered by an internal combustion engine and by an electric motor that uses energy stored in a battery. The battery is charged through regenerative braking and by the internal combustion engine and does not plug in to charge.	PHEVs are powered by an internal combustion engine and an electric motor that uses energy stored in a battery. The vehicle can be plugged in to an electric power source to charge the battery.	They use hydrogen to generate electricity on-board the vehicle. Hydrogen is an abundant element that can be readily derived when water (H_2O) is broken down into 2 hydrogen molecules and 1 oxygen molecule. They are then harnessed separately, and consequently, hydrogen used as fuel for the vehicle. Refueling a fuel cell vehicle is comparable to refueling a conventional car but at a hydrogen refueling station, taking less than 10 minutes.
Components	• Electric motor • Battery pack • Regenerative braking	• ICE • Petrol/diesel • Electric motor • Battery pack • Regenerative braking	• ICE • Petrol/diesel • Electric motor • Battery pack • Regenerative braking	• Electric motor • Hydrogen tank • Battery pack

3 Why electric mobility?

EVs are environmentally friendly

They emit no tailpipe pollutants and when powered from renewable energy, they have lower CO_2 emissions overall. Even up to a certain share of fossil electricity, EVs cause less emissions due to more efficient energy conversion into movement.

EVs reduce noise pollution

This is because EVs only have one moving part, the motor, unlike the many parts of the internal combustion engine (ICE). When traveling at average speeds of below 20 km/h, they emit very minimal sound that hardly nearby pedestrians can hear it. At faster speeds, the friction of the tires against the road and wind resistance against the windshield make the car more audible[6].

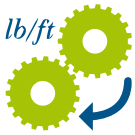
10 years
long lasting batteries

Lithium-ion batteries used for EVs are long-lasting

The batteries usually last 10 years before losing enough performance that one could consider replacing them. They retain about 90% of their power capacity upon removal and can be reused as power storage for domestic and commercial buildings or to store electricity from solar panels and wind turbines. The batteries can also be recycled to harvest raw materials further reducing the environmental footprint[7].

Electric motors are more efficient than ICEs

They convert about 90% of the electrical energy to motion. Conventional vehicles only convert about 30% of the energy stored in fuel to power at the wheels. The problem of fuel loss during traffic snarl-ups is also eliminated as EV batteries only consume power while in motion.



EVs have a better torque than conventional vehicles

They offer instant response during acceleration and braking[8].

Electric mobility reduces energy dependence

Electricity is a domestic energy source unlike petrol or diesel. This saves the consumers and the country from high and fluctuating costs for importing petroleum.

Electric mobility saves money

Though EVs are comparatively expensive on initial purchase because of the high cost of batteries, they are cheaper to run in the long term because of the minimal maintenance and running costs. In place of an engine and a gearbox, EVs run on batteries. With less moving parts, there is less wear further limiting the need for servicing. The motor and battery are also not repaired or serviced, only replaced in case of any eventuality.

Competitive value of electric mobility in Kenya

A local comparison study conducted in 2017 by Drive Electric, proved the competitive value of electric vehicles in the country[9].

Table 1: Competitive value comparison of an electric vehicle and a petrol vehicle

Study Parameter	Electric Car	Petrol Vehicle
Battery/Engine Capacity	24 kWh	1500 cc
Power consumption per km	0.2 kWh	0.09 L (0.819 kWh)
Average fuel economy	5 km/KWh	12.68 km/L (9.1kWh)
Energy cost/km travelled	Kes 4.00 (Kes 20.91/KWh)	Kes 8.50 (Average Petrol Cost of Kes 106.3/l)
Torque (Nm)	350	150
Tail pipe CO_2 emissions per km	Zero	185.20 gm/CO_2e*
Cost of maintenance (Engine related service schedule)	Nil (service scheduled at 12,000 km)	Kes 7,500/service (Service scheduled at every 5,000 km)

** (Notter & Füssler, 2018)*

Source: Drive Electric (2017) and GIZ

How do I charge my vehicle?

Charging an EV requires plugging it into a charger connected to the electric grid, also called Electric Vehicle Supply Equipment (EVSE). There are different categories of chargers, based on the maximum amount of power the charger provides to the battery from the grid.

- ***Level 1:*** Provides charging through a 120V alternating current (AC) plug and does not require installation of additional charging equipment. Most often used in homes.
- ***Level 2:*** Provides charging through a 240V (for residential) or 208V (for commercial) plug and requires installation of additional charging equipment. It is used in homes, office buildings, and for public stations.
- ***DC Fast Charge:*** Provides a high-power Direct Current (DC) current generally up to 120kW directly to the battery and requires highly specialized, high-powered equipment as well as special equipment in the vehicle itself. Used most often in public charging stations, especially along heavy traffic corridors or highways.

In some EVs, the battery can simply be removed and exchanged for a fully charged battery or taken home for charging. This equalizes the standard time of fuelling a conventional vehicle[10].

Where do I charge?

Charging of EVs can be done at home, at the mall, at work or in public charging stations. Charging at home or work is possible via the standard electrical power points (240-volt AC/15 AMP) electricity supply. DC fast charger outlets are installed in large residential and commercial buildings or along busy highways. At the moment, there are fast chargers set up at the Hub, Two Rivers and Thika Road Malls in Nairobi by Nopia. The viability of charging through induction as an advanced technology is also being tested. It will eliminate long charging times as induction can also take place while the vehicle is in motion on the road[11].

Doesn’t charging take too long?

Full charging times can range from under 30 minutes to over 8 hours based on the type of charger, type of battery, charge level and its capacity. Level 1 and Level 2 chargers are best suited for overnight charging or during long stop-overs. DC Fast Chargers are used when there is the need for a quick recharge within a short amount of time. Further research into battery technologies continues to reduce the cost of batteries, increasing efficiency and driving range of electric vehicles and decreasing charge times.

What happens at the battery end of life?

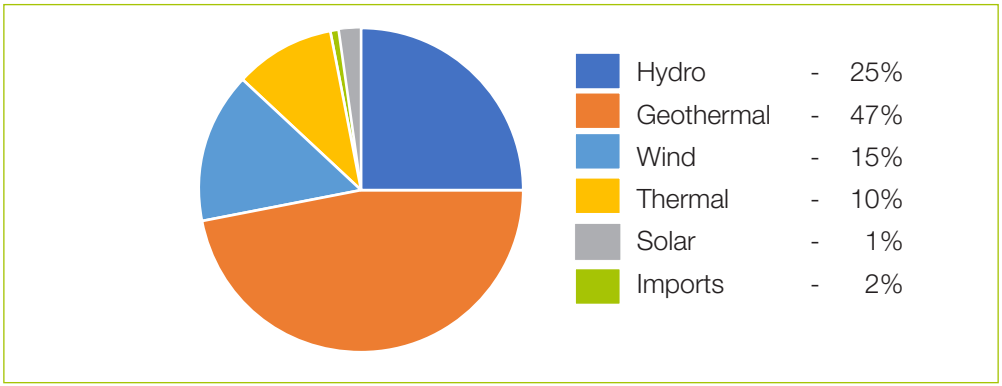
When the electric vehicle batteries reach their end-of-life (EOL) point, the battery can be removed for recycling in various non-vehicular uses non-vehicular uses. Moreover, some of the materials can be recovered and reprocessed to make new batteries, further reducing emissions during decommissioning[12]. Currently there are no EV battery recycling facilities in the country, but the government is exploring modalities for battery re-use and recycling.

4 Kenya's electricity demand and power supply

Is the power grid fit for electric mobility?

Kenya currently generates over 2700MW, out of which over 80% is renewable, against the demand at 1860MW[13]. The excess 800MW could be utilized to power an electric transport fleet. The demand goes even lower to 1000MW during off-peak hours between 10pm and 6am; this is the ideal time for the slow charging at home. The electricity access rate in the country also stands at 73.4% as of the end of April 2018, but it is also possible through decentralized power inputs such as solar panels to power electric mobility in areas not connected to the national grid[14].

Figure 2: Kenyan Electricity Supply Mix[15]



Source: Ministry of Energy, 2019

5 What does electric mobility mean for the economy?

New industry = new opportunities

The adoption of electric powered vehicles will reduce the levels of noise pollution, air pollution, GHG emissions and overall expenditure on oil imports for the country while creating a more climate-friendly environment. A shift to electric mobility will also lead to creation of employment; directly and indirectly in the automotive, electronics and IT industries as well as in other industries such as in the deployment and operation of charging infrastructure, local assembly and maintenance of EVs and recycling or reuse of the battery at the battery's end of life. There is therefore need for capacity building through training on development, deployment and maintenance of e-mobility infrastructure. A study by the European Association of Electrical Contractors shows that more than twice as many jobs are created in the electricity value chain as are lost in automotive manufacturing. The study concludes that by 2030 a total of nearly one million permanent jobs could be created globally in fields such as electricity generation, civil and road works, battery cell manufacturing, installation and maintenance. These are high quality, local, green jobs[16].

6 Do we have electric motor vehicles in Kenya?

Kenya had about 350 electric motor vehicles by December 2018[17]. Some of the emerging industry leaders are:

Nopia Ride is the first fully electric ride sharing app established in August 2018. Hailed as an 'eco-taxi', it offers zero-emission rides allowing the company to charge less compared to other ride hailing apps, pay their drivers more and protect the environment. The company is truly competitive in the market as drivers do not pay for fuel, enabling them to make more than their competitors. The company is scaling up, building three charging stations at Two Rivers Mall, The Hub and Thika Road Mall.

Opibus is a Nairobi-based green energy company that deals with electric vehicle conversion. Its initial focus has been on conversion of off-road vehicles, for safari use. They are also developing an electric motorcycle through their subsidiary Flux Motors[18].

Solar E-Cycles develops electric bicycles, scooters and 3- and 4-wheel vehicles. The solar powered light electric vehicles can travel 50 km a day just with power from the solar rooftop. The three wheelers can serve as replacement for *tuktuks* (auto rickshaw) which are popular in urban areas for short distances. The inexpensive solar car can serve as a sustainable economic development tool in isolated off-grid rural areas in Africa[19].

Drive Electric offers services such as charging station installation, operation and maintenance, e-mobility consultancy, electric vehicle leasing and fleet analysis.[20].

> Driving an electric vehicle is not complicated, it is similar to any other automatic ICE vehicles only that it is silent when you switch it on and when driving at low speed. People are used to vehicles with loud engine sound, so they might not be aware of a car in motion around them. For this reason you have to be careful of your surroundings when starting and driving an electric car.
>
> **Amos Njau**

Photo: Carol Mutiso

7 Current developments on e-mobility in Kenya

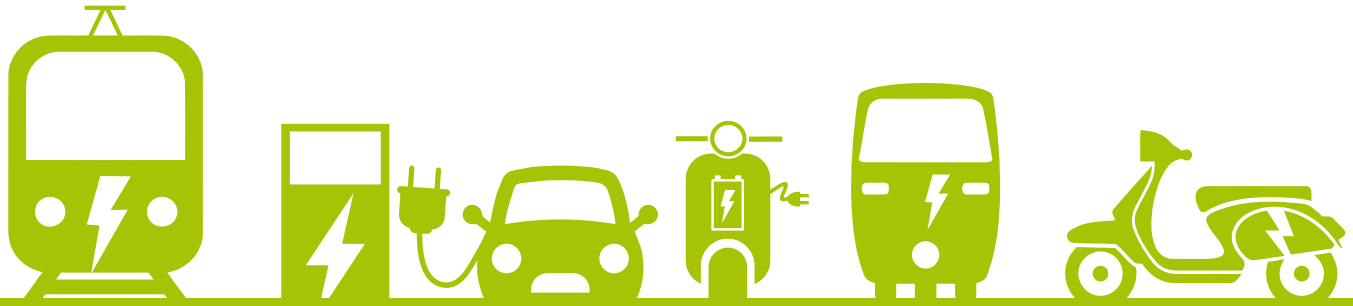
E-mobility is key in supporting the government's commitment to transform the transport sector into a low-carbon, efficient and reliable system that will drive social and economic growth in the country—furthermore it presents a new business opportunity. The SDoT has made it a priority to create an enabling environment for the development of the sector:

1 Reduction of excise duty on electric vehicles

The Finance Bill of 2019 has proposed a reduction on the excise duty for all vehicles with only electric motor for propulsion (BEVs) from 20% to 10%[21].

2 Development of standards for electric vehicles

The Kenya Bureau of Standards has developed and adopted standards that apply to electric vehicles imported into the country. Up until now, a total of 24 standards have been developed and adopted, covering specifications and testing procedures for safety aspects as well as performance and power consumption elements[22].



3 Endorsement of private and development sector support

- The government is involved in an e-mobility pilot with UN Environment where they will engage the City of Kisumu and Kenya Power & Lighting Company Limited through deployment of a total of 50 electric motorcycles on a pilot basis[23].
- The SIEMENS Stiftung Foundation is piloting electric trucks, cargo-bikes and boats in Western Kenya through WE!Hub Victoria Ltd.

4 Through cooperation with GIZ, the State Department of Transport is:

- Creating the necessary policy environment and regulatory framework for the uptake of e-mobility
- Developing awareness materials on the feasibility and advantages of e-mobility in the country

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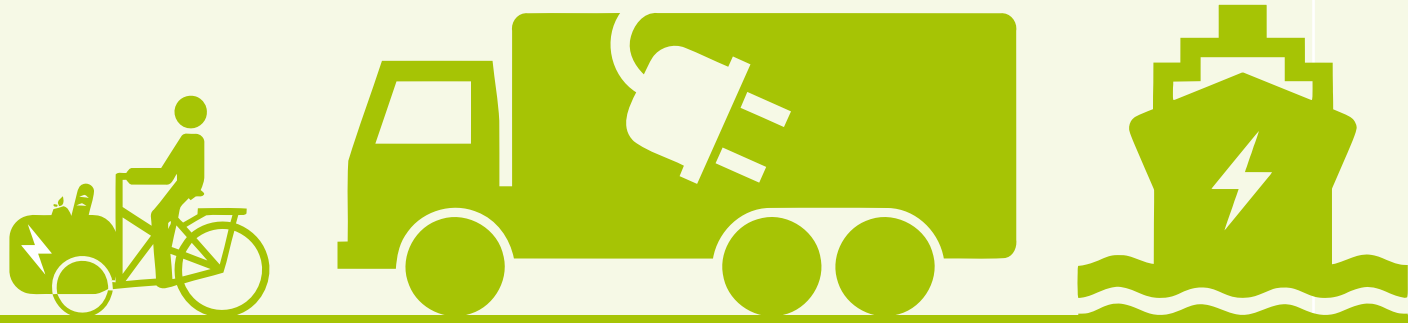

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Photo: Shutterstock

GIZ, through the **The Advancing Transport Climate Strategies (TraCS) Project**; a technical assistance project focusing on institutionalizing climate change functions within the State Department for Transport, is championing the uptake of e-mobility for the transport sector in view of Kenya's national emissions reduction target. The project is funded by the German Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety's (BMU) International Climate Initiative (IKI).

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