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

STATE DEPARTMENT FOR TRANSPORT

Electric Vehicle Standards in Kenya

Draft Summary Report

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List of Acronyms

ADT	Applicable driving test
BAU	Business as usual
BEV	Battery electric vehicle
BMU	German Federal Ministry for the Environment, Nature Conservation and Nucelar Safety
DUT	Device under test
EV	Electric vehicle
GHG	Greenhouse gases
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
HEV	Hybrid electric vehicle
ICE	Internal combustion engine
IKI	International Climate Initiative
KEBS	Kenya Bureau of Standards
$MtCO_2e$	Metric Ton Carbon Dioxide Equivalent
NCCAP	National Climate Change Action Plan
RESS	Rechargeable energy storage systems
PHEV	Plugin hybrid vehicle
SDoT	State Department of Transport
SOC	Battery state of charge
TraCS	Advancing Transport Climate Strategies Project

1. Introduction

Electric mobility has been prioritised as a mitigation action that offers immense health and sustainability benefits for the sector and the country at large. SDoT, is working on advancing e-mobility in Kenya with support from GIZ and other development partners.

Following consultative meetings on electric mobility hosted by the State Department for Transport, several issues have been identified that need to be addressed to enhance uptake of electric mobility in the country.

This include:

a) Update the vehicle registration system to include electric vehicles

b) Assess how electric vehicles are affected by the current CRSP

c) Development of a user guide for the electric vehicle standards

Part of these issues were addressed by a consultancy study supported by GIZ through the Advancing Transport and Climate Strategies (TraCS) Project. This report is among the preliminary steps towards development of a user guide for electric vehicles. It provides a summary of electric vehicles standards developed by the Kenya Bureau of Standards. Two other reports addressing the other two components above have also been developed under the study.

1.1 Background

Kenya aims to reduce its greenhouse gas (GHG) emissions by 32% by the year 2030 compared to the business as usual (BAU) scenario. In 2016, the country enacted the Climate Change Act which mandated every state agency to set up a Climate Change Coordination Unit. The role of the unit is to coordinate mainstreaming of all climate change duties in the sector/agency and the Advancing Transport and Climate Strategies (TraCS) project has made significant strides in institutionalizing the Climate Change Coordination Unit at the SDoT.

The Kenyan transport sector accounts for about 12% of Kenya's total GHG emissions, which amounts to 11.25 Million tonnes of Carbon Dioxide Equivalent ($MtCO_2e$) as at 2015 (according to the Transport Sector Climate Change Annual Report, 2018/2019). The emissions are increasing at a faster rate than in other sectors. The sector's emissions reduction target, according to the first Nationally Determined Contribution (NDC)Target, aims to reduce 3.46 $MtCO_2e$ against the Business as Usual (BAU) by adopting a sustainable

and low carbon mobility pathway. From an analysis done by TraCS, an increased uptake of electric mobility has the second highest mitigation potential, contributing to a reduction of about 0.6 MtCO2e against the BAU scenario. This is largely due to a relatively low grid emission factor in the country's electric grid.

Electric mobility is therefore a key area of action to contribute to Kenya's NDC and as a result has been highlighted as a key action in the National Climate Change Action Plan (NCCAP) 2018-2022. To progress this, TraCS has convened various stakeholder consultations involving public and private sector experts, with the objective of identifying barriers that hinder the uptake of electric mobility in Kenya.

This report is a result of these efforts and aims at providing a quick overview and an easily accessible summary of the available electric vehicle standards in Kenya. The potential uptake of EV might be stunted if no adequate standards are in place, in particular in terms of maintaining compatibility between country jurisdictions, safety, and environmental sustainability.

This study was commissioned by the State Department for Transport and conducted by Strathmore University and Knights Energy. It was supported by funding from the TraCS project, a project implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH and funded through the International Climate Initiative (IKI) of the German Federal Ministry for Environment, Nature Conservation and Nuclear Safety (BMU).

2. KEBS Standards on electric vehicles

Standards are tools that provide a basis for mutual understanding between individuals and organizations. They can be national, regional or global and are important since they facilitate business interactions and enable organizations to comply with relevant laws and regulations. They also support the introduction of innovative products and manufacturing since they guide and enable interoperability in new and existing products, services and processes.

3.1 Standard development process

The Kenya Bureau of Standards (KEBS) is a government agency mandated with the development and promotion of standards for Kenya's industries and organizations. It preserves the country's quality infrastructure. Standards facilitate trade, support Kenyan industries and ensure the sustainability of production systems. Standards in Kenya are developed by a panel of experts called 'technical committee'. A technical committee comprises of local industry players, academia, government bodies and any relevant local or international stakeholder in the given field.

The need for a standard in Kenya is usually identified by stakeholders inside or outside of the technical committee. KEBS welcomes participation of external stakeholders in this process. The stakeholders request KEBS, through its respective technical committee, to develop or adopt a standard. The committee, through its secretary, then seeks out existing standards in the given topic and presents them for adoption or initiates a new standards development process. A summary of this process as described in KS 01-1: 2010 is as follows:

- A draft standard is developed and circulated in the technical committee for comments, with the assistance of the committee secretary.
- Once the comments are addressed and consensus is reached, the draft standard is shared with stakeholders and the public for a public review process.
- The comments obtained from the public review process are addressed and discussed by members of the technical committee and deliberations are compiled into an amended draft.
- The amended draft is then prepared and shared with members of the technical committee for commenting and voting. If no agreement can be reached, the draft stays at the technical committee for further edits.

- If an agreement is reached, the draft standard is forwarded for approval to become a Kenyan standard.

Current electric vehicle standards in Kenya were developed through a similar process in the course of 2018. The standards specify requirements for performance, safety and testing of electric motorcycles, mopeds, and electrically propelled road vehicles (passenger cars and light commercial vehicles). Out of the 21 electric vehicle standards, 14 are on electrically propelled road vehicles, 4 are on mopeds and 3 are on hybrid electric vehicles (see table 1).

The standards outline safety specifications for all electric vehicles in the country and define the operation and testing procedures to be used for manufactured electric vehicles. They are used to assess the conformance of both imported and locally assembled/manufactured electric vehicle to stipulated requirements as per Kenyan laws and regulations. Only vehicles that meet the stipulated requirements as per Kenyan standards can operate in the country.

3.2 List of electric mobility standards

Table 1: EV Standards in Kenya

Standard	Title
KS ISO 6469-1:2019	Electrically propelled road vehicles-Safety specifications -Part 1: Rechargeable energy storage system (RESS) / Road vehicles
KS ISO 6469-2:2018	Electrically propelled road vehicles-Safety specifications -Part 2: Vehicle operational safety means and protection against failures. / Road vehicles
KS ISO 6469-3:2018	Electrically propelled road vehicles-Safety specifications -Part 3: Electrical safety / Road vehicles
KS ISO 6469-4:2015	Electrically propelled road vehicles-Safety specifications -Part 4: Post crash electrical safety. / Road vehicles
KS ISO/TR 8713:2012	Electrically propelled road vehicles-Vocabulary. / Road vehicles.
KS ISO 13063:2012	Electrically propelled mopeds and motorcycles-Safety specifications. / Road vehicles

KS ISO 8715:2001	Electric road vehicles-Road operating characteristics. / Road vehicles
KS ISO 13064-1:2012	Battery-electric mopeds and motorcycles-Performance-Part 1: Reference energy consumption and range. / Road vehicles
KS ISO 13064-2:2012	Battery-Electric mopeds and motorcycles-Performance-Part 2: Road operating characteristics. / Road vehicles.
KS ISO/TR 13062:2015	Electric mopeds and motorcycles-Terminology and classification. / Road vehicles
KS ISO 17409:2015	Electrically propelled road vehicles-Connection to an external electric power supply-Safety requirement. / Road vehicles
KS ISO 23274-1:2013	Hybrid-electric road vehicles-Exhaust emissions and fuel consumption measurements-Part 1: Non-externally chargeable vehicles.
KS ISO 23274-2:2012	Hybrid-electric road vehicles- exhaust emissions and fuel consumption measurements part 2: externally chargeable vehicles
KS ISO/TR 11955:2008	Hybrid-electric road vehicles-Guidelines for charge balance measurement.
KS ISO 8714:2002	Electric road vehicles-Reference energy consumption and range-Test procedures for passenger cars and light commercial vehicles. / Road vehicles
KS ISO/PAS16898:2012	Electrically propelled road vehicles-Dimensions and designation of secondary lithium-ion cells. / Road vehicles.
KS ISOPAS 19363:2017	Electrically propelled road vehicles-Magnetic field wireless power transfer-Safety and interoperability requirements. / Road vehicles
KS ISO/PAS19295:2016	Electrically propelled road vehicles-Specification of voltage sub-classes for voltage class B. / Road vehicles
KS ISO 12405-4:2018	Electrically propelled road vehicles-Test specification for lithium-ion traction battery packs and systems-Part 4: Performance testing / Road vehicles

KS ISO 15031-6: 2015	Road vehicles - Communication between vehicle and external equipment for emissions-related diagnostics Part 6: Diagnostic trouble code definitions
KS ISO 18300:2016	Electrically propelled vehicles-Test specifications for lithium-ion battery systems combined with lead-acid battery or capacitor. / Road vehicles

3.3 Electric Mopeds and Motorcycles

These are light motorcycles that are propelled by an engine and have bicycle pedals.

3.3.1 KS ISO/TR 13062:2015 - Electric mopeds and motorcycles; Terminology and classification

This standard presents a vocabulary of terms and related definitions for mopeds and motorcycles. The terms in this standard are specific to the electric propulsion systems of electrically propelled mopeds and motorcycles.

3.3.2 KS ISO 13064-1:2012 - Battery electric mopeds and motorcycles performance

Part 1: Reference energy consumption and range

Part 1 of this standard specifies test procedures for measuring the reference energy consumption and reference range of electric motorcycles and mopeds with traction batteries as the only power source for vehicle propulsion. Test conditions such as vehicle conditions, atmospheric conditions, rider and riding position, and road conditions are both specified to guide the test procedure. The steps that guide the test procedure are:

- Initial charging of the traction battery.
- Application of the appropriate test sequence.
- Measurement of the reference range.
- Consumption at the stationary external power source.
- Charging of the traction battery and measurement of the energy consumption at the mains and the calculation of the reference energy consumption.

The driving cycles (basic urban and extra urban) for both mopeds and motorcycles are specified, thus guiding the test sequence to determine range.

Part 2: Road operating characteristics

Part 2 of the standard specifies the procedures for measuring the road performance of electric motorcycles and mopeds with traction batteries as the only power source for vehicle propulsion. The road performance comprises determining road operating characteristics such as speed, acceleration, hill climbing ability, range at 80% maximum speed, complete battery discharge, maximum speed, partial battery discharge, acceleration ability, hill starting ability and uphill speed. Test conditions specified in the

standard are battery conditions, vehicle conditions, atmospheric conditions, road/track condition, rider and riding state conditions.

3.3.3 KS ISO 13063:2012 - Electrically propelled mopeds and motorcycles-Safety specifications. / Road vehicles.

This standard specifies requirements for functional safety means, protection against electric shock and the on-board rechargeable energy storage systems intended for the propulsion of any kind of electrically propelled mopeds and motorcycles when used in normal conditions. It is applicable only if maximum working voltage of the on-board electrical circuit does not exceed 1000 V a.c. or 1500 V d.c. This standard does not provide comprehensive safety information for manufacturing, maintenance and repair personnel. The list of requirements specified include voltage requirements, power cable, connectors and conduit specifications. This standard also stipulates the measurement and requirements for protection of persons against electrical shock of voltage class B electric components.

3.4Hybrid Electric Vehicles

These are electric vehicles that have an internal combustion engine and has an electric propulsion system.

3.4.1 KS ISO 23274-1:2013 - Hybrid-electric road vehicles; Exhaust emissions and fuel consumption measurements

Part 1: Non-externally chargeable vehicles

This standard specifies test procedures for measuring the exhaust emissions, electric energy and fuel consumption of hybrid-electric vehicles. The scope of the standard applies to vehicles with the following characteristics:

- The vehicle is classified as passenger car or light duty truck, as defined in the region.
- The nominal energy of the rechargeable energy storage system (RESS) is at least 2% of the total energy consumption over an applicable driving test (ADT)
- ICE only using liquid fuels (for example, gasoline and diesel fuel).
- In the case of the vehicles with ICE using other fuel (e.g. compressed natural gas [CNG], liquefied petroleum gas [LPG], hydrogen), this standard can be applied except in the measurement of consumed fuel.

The standard proposes procedures for correcting the measured emissions and fuel consumption of hybrid electric vehicles (HEVs), in order to obtain the values when the battery state of charge (SOC) of the RESS does not remain the same between the beginning and the end of an ADT.

European, North American and Japanese test procedures are referred to in this standard.

Part 2: Externally chargeable vehicles

Part 2 of the standard specifies the procedures for measuring the exhaust emissions, electric energy and fuel consumption of hybrid-electric vehicles that are recharged externally. European, North American and Japanese test procedures are referred to in this standard.

3.4.2 KS ISO/TR 11955:2008 - Hybrid-electric road vehicles; Guidelines for charge balance measurement

This technical report describes the procedures of charge balance measurement to ensure necessary and sufficient accuracy of a fuel consumption test on HEV with batteries. The charge balance of a RESS is measured during a fuel consumption test of non-externally chargeable HEV so as to determine the effect of energy change on fuel consumption. The standard describes detailed guidelines for charge balance measurement methods including requirements for current measuring systems to fulfil the required total accuracy prescribed in KS ISO 23274-1:2013.

3.5Electrically Propelled Road Vehicles

Electrically propelled road vehicles highlighted in the following standards are passenger cars and light commercial vehicles.

3.5.1 KS ISO 12405-4:2018 - Electrically propelled road vehicles-Test specification for lithium-ion traction battery packs and systems-Part 4: Performance testing / Road vehicles

This standard specifies the test procedures for lithium ion battery packs and systems. The test procedures are limited to the basic characteristics of performance, reliability and electrical functionality for the battery packs and systems for either high-power or high-energy application. High power battery pack applications are in HEV. High energy battery pack applications are in battery electric vehicles (BEV) and plug-in hybrid electric vehicles (PHEV). The performance tests carried out on the batteries are - energy and capacity at room temperature, at different temperatures and discharge rates, power and internal resistance, no load state of charge (SOC) loss, SOC at storage, cranking power at low temperature, at high temperature, energy efficiency, at fast charging and cycle life.

3.5.2 KS ISO 18300:2016 - Electrically propelled vehicles-Test specifications for lithium-ion battery systems combined with lead-acid battery or capacitor. / Road vehicles

This standard describes the test specifications or lithium ion battery packs that are combined with lead acid batteries or electric double layer capacitors that are used in voltage class A systems. Voltage class A systems are systems that have a maximum operating voltage that is less than 30Vac (rms) or 60Vdc. The test procedures highlighted in the standard are - rated capacity test, micro-cycle test and cycle life test. A micro-cycle is a charge and discharge cycle of a battery in 60 seconds.

3.5.3 KS ISO 6469-1:2019 - Electrically propelled road vehicles-Safety specifications-Part 1: Rechargeable energy storage system (RESS) / Road vehicles.

This standard specifies safety requirements for rechargeable energy storage systems (RESS) of electrically propelled road vehicles for the protection of persons. The test preparation procedure includes general test conditions, test parameters such as temperature, measurement accuracy, preparation and pre-conditioning of the Device Under Test (DUT) and preparation of the RESS subsystems and test bench. The testing begins with general safety requirements that includes checking for evidence of leakage, rapture, fire and explosion and isolation resistance. The mechanical test is done in two steps, vibration and mechanical shock under specified conditions. In the climatic test, the DUT is subjected to thermal shock cycling that involves cycling and storing the battery in specified temperature range.

In the simulated vehicle accident tests, the test is carried out in two parts:

- RESS level-based test that includes inertia load at a vehicle crash, contact force at a vehicle crash.
- Vehicle based-test; immersion into water and exposure to fire.

In the electrical test, the RESS subsystem is tested for overcurrent protection.

In the functional test, the DUT is tested for overcharging protection, over discharging protection and protection against overheating.

3.5.4 KS ISO 6469-2:2018 - Electrically propelled road vehicles-Safety specifications -Part 2: Vehicle operational safety means and protection against failures. / Road vehicles.

This standard specifies requirements for operational safety specific to electrically propelled road vehicles, for the protection of persons inside and outside the vehicle.

The requirements specified in this standard should be met across the range of environmental and operating conditions for which the EV is designed to operate, as specified by the vehicle manufacturer.

These safety measures include driving-enabled mode; movement of the vehicle by its propulsion system shall be possible only in the driving-enabled mode. To switch the propulsion system from shut-off condition to driving-enabled mode, at least two deliberate and distinctive actions shall be necessary. This is mostly brought to effect using a drive selector (gear-selector), to engage different movement modes such as forward, reverse and park operations. This gives the driver full control.

This standard also specifies driver (user) related specifications of the electrically propelled vehicle such as indication of reduced propulsion power if a means to automatically reduce vehicle's power is present.

3.5.5 KS ISO 6469-3:2018 - Electrically propelled road vehicles-Safety specifications-Part 3: Electrical safety / Road vehicles.

This standard specifies electrical safety requirements for voltage class B electric circuits of electric propulsion systems and conductively connected auxiliary electric systems of electrically propelled road vehicles. It specifies electrical safety requirements for protection of persons against electric shock and thermal incidents. Voltage classes are defined and grouped in classes ranging from class A, B, B1, B2.

Table 2: Voltage classes

Voltage class	Maximum working voltage	
	DC in V	AC in V (rms value)
A	$0 < U \leq 60$	$0 < U \leq 30$
B	$60 < U \leq 1\,500$	$30 < U \leq 1\,000$
B1	$60 < U \leq 75$	$30 < U \leq 50$
B2	$75 < U \leq 1\,500$	$50 < U \leq 1\,000$

The requirements for protection of persons against electrical shock specified in the standard include:

- Basic protection against electrical shock.
- Fault protection and additional measures.
- General requirements for protective provisions: Requirements for insulation, requirements for protective barriers and protective enclosures, requirements for connectors and insulation coordination.
- Alternative approach for protection against electrical shock.

The standard also specifies the protection against thermal incidents, overload protection and short-circuit protection.

3.5.6 KS ISO 6469-4:2015 - Electrically propelled road vehicles-Safety specifications-Part 4: Post crash electrical safety. / Road vehicles.

This standard specifies safety requirements for the electric propulsion systems and conductively connected auxiliary electric systems of EVs for the protection of persons inside and outside the vehicle after a crash. The scope of the standard is electrically propelled road vehicles with voltage class B electric circuits.

This standard, however, does not apply to motorcycles and mopeds and does not specify any crash test procedure. The safety requirements of this standard apply to applicable vehicles in accordance with published crash test procedures of each country or region.

The standard does not provide comprehensive safety information for first responders, emergency services, maintenance, and repair personnel.

3.5.7 KS ISO/TR 8713:2012 - Electrically propelled road vehicles-Vocabulary. / Road vehicles.

This Technical Report outlines a vocabulary of terms and the related definitions used in electrically propelled road vehicles.

3.5.8 KS ISO 8715:2001 - Electric road vehicles-Road operating characteristics. / Road vehicles.

This standard specifies the procedures for measuring the road performance of purely electrically propelled passenger cars and commercial vehicles. The maximum authorized total mass of the vehicles is 3500 kg. The road performance comprises road operating characteristics such as speed, acceleration and hill climbing ability.

The test procedure includes a maximum thirty-minute speed test, complete battery discharge test, maximum speed test, acceleration ability from 0-50Km/h and from 50-80km/h, hill climbing ability and hill starting ability.

3.5.9 KS ISO 17409:2015 - Electrically propelled road vehicles; Connection to an external electric power supply - Safety requirements

This standard specifies electric safety requirements for conductive connections of electrically propelled road vehicles to an external electric power supply using a plug or vehicle inlet. It applies to electrically

propelled road vehicles with voltage class B electric circuits. This standard may be applied to electric motorcycles and mopeds if no dedicated standards for these vehicles exist. It applies only to vehicle power supply circuits and dedicated power supply control functions used for the connection of the vehicle to an external electric power supply. Various requirements for a.c and d.c electric power supply characteristics and conditions for operation such as current characteristics, power flow, power factor and vehicle connector locking are specified. The standard specifies test procedures so as to guide component testing for electric vehicle power supply equipment.

3.5.10 KS ISO 8714:2002 - Electric Road Vehicles - Reference energy consumption and range - Test procedures for passenger cars and light commercial vehicles

This standard describes the test procedures for passenger cars and light commercial vehicles. The standard is limited to a scope of vehicles that have a total mass of 3500kg and a maximum speed greater than 70km/h. The test procedures consist of four steps - initial charging of traction batteries, application of the designated test sequence, and the measurement of the reference range and consumption at the mains, charging of the traction battery and measurement of the consumption at the mains and calculation of the reference energy consumption.

Three different driving cycles have been referred to as an optional basis for the definition of test sequence in the standard: European driving cycle, US driving cycle and Japanese driving cycle.

3.5.11 KS ISO/PAS16898:2012 - Electrically propelled road vehicles-Dimensions and designation of secondary lithium-ion cells. / Road vehicles.

This standard specifies the designation systems, shapes and dimensions of secondary lithium ion cells for the integration into battery packs that are used in electric vehicles. It also specifies the systems used in electrically propelled road vehicles including the position of the terminals and any overpressure safety device (OPSD). The cell dimensions in the standard are recommended for passenger vehicles up to 3500kg. The shapes of lithium ion cells that are looked at are cylindrical, prismatic and pouch cells.

3.5.12 KS ISO/PAS 19363:2017 - Electrically propelled road vehicles-Magnetic field wireless power transfer-Safety and interoperability requirements. / Road vehicles

This standard outlines the safety and interoperability requirements for magnetic field wireless power transfer in electric vehicles. It defines the requirements and operation of the on-board vehicle equipment

that allows magnetic field wireless power transfer (MF-WPT). The scope of this standard is limited to passenger cars and light duty vehicles. The following aspects of EVs are addressed in the standard - transferred power, ground clearance, and interoperability requirements among differently classified EV devices and associated off vehicle systems, performance requirements under various conditions including among different manufacturers and classifications, safety requirements and test procedures.

3.5.13 KS ISO/PAS19295:2016 - Electrically propelled road vehicles-Specification of voltage sub-classes for voltage class B. / Road vehicles

This standard specifies the voltage sub-classes for road vehicles that are classified as voltage class B. Class B voltage is a classification of an electrical component or circuit with a maximum operating voltage of between 30Vac (rms) to 1000Vac (rms) or between 60Vdc to 1500Vdc.

The specifications and characteristics of the voltage sub-classes described in the standard highlights the following areas - component operating status, voltage operating ranges, under and over-voltages, and voltage transients and ripple for components.

3.5.14 KS ISO 15031-6: 2015 - Road vehicles - Communication between vehicle and external equipment for emissions-related diagnostics Part 6: Diagnostic trouble code definitions

This standard specifies the uniformity for standardized Diagnostic Trouble Codes (DTC) that electrical and electronic On-Board Diagnostic (OBD) systems of motor vehicles are required to report when malfunctions are detected. DTC are codes that are used by vehicle manufacturers to diagnose problems in vehicles. The standard also provides guidance for uniform messages that are associated with the DTC

3. Recommendations

Below are key recommendations established based on this study:

1) **Adjust testing procedures to account for locally manufactured or retrofitted electric vehicles**

   Current electric vehicle standards are based on testing procedures developed in Europe, US, and Japan. These testing procedures are applicable to electric vehicles that use European, American, or Japanese technologies which limits locally developed technologies to those options, thus constraining local innovation. Therefore, there is need for an ecosystem analysis of the local electric vehicles manufacturing sector and develop local testing procedures that include locally manufactured or retrofitted electric vehicles guided by the local environment.

2) **Account for new technologies that come with electric mobility**

   Standards that cover retrofitting, battery swapping, and other new technologies associated with electric mobility should be developed in collaboration with stakeholders, especially local manufacturers. This will ensure the safety of the technologies and guide their progression while protecting the intellectual property of companies.

3) **Develop standards for electric motorcycles and mopeds**

   According to the Motorcycle Assemblers Association of Kenya (MAAK), there are over 600,000 commercial motorcycles in Kenya. These motorcycles contribute significantly to the percentage of GHG emissions contributed by the transport sector. Therefore, emphasis should be put into the development of moped standards to promote the use of electric motorcycles and increase their adoption. These include safety specifications for magnetic field wireless power transfer, protection against failures, electrical components and post-crash conditions for motorcycles and mopeds.

4) **Develop standards for safety requirements when connecting to external electric power supply**

   Standards and regulations should be developed on the safety requirements when connecting electric vehicles to external electric power supplies. Electric vehicle charging stations will develop with the popularity of electric vehicles. Standards and regulations on the safety of electric vehicle charging stations should also be developed.

5) **Formulate standards and regulations for electric bicycles and tricycles**

   Standards should also be developed for electric bicycles and tricycles as there is a high demand for them. Besides standards, regulations should be developed to aid the classification of these bicycles

and tricycles since they are faster than normal bicycles and tricycles, hence the need to ensure the safety of users and pedestrians.

6) **Consider other types of batteries**

   Lithium iron phosphate and nickel manganese cobalt batteries are the most common types of batteries used in electric mopeds and bicycles. Current standards do not cover these batteries and their application satisfactorily, thus, there is a need to develop new standards that cover a broader range of battery types.

7) **Expand KS1515 by inspection procedures**

   The current standard for vehicle inspection, KS1515, only covers general safety requirements for all vehicles but does not have inspection procedures for electric vehicles. Therefore, a standard that includes inspection procedures for electric vehicles is needed.

8) **Care for battery waste reuse and disposal of EVs**

   Standards and procedures for battery waste reuse and disposal for electric vehicles should be developed and tailored to the electric vehicles sector. Currently, the National Environment Management Authority (NEMA) has these standards but they are not tailored to the electric vehicles sector, where some batteries can be reused for solar photovoltaics installation.

9) **Build testing laboratories and expand testing infrastructure**

   The expansion of local manufacturing of electric vehicles calls for the development of well-resourced and independent testing laboratories, without which the safety of locally developed electric vehicles might be cast in doubt. Therefore, there is a need to assess current testing capacity and infrastructure in the country and develop both where need is found.

10) **Build multi-stakeholder alliances between government agencies**

    These recommendations touch on different government agencies, hence there is need to have a multiagency and multi-stakeholder working group to guide the development and adoption of these standards. Further studies are also required to the local electric mobility sector and identify gaps in electric mobility standards, especially pertaining local assembly and manufacturing, which can be a starting point for the working group.

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