BRIEFING

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Using policy and regulation to pave the way for two-wheeler electrification in Vietnam

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1. INTRODUCTION

Vietnam aims to reduce its GHG emissions and air pollution and is embracing international and national commitments to achieve this. In September 2020, Vietnam submitted its updated NDC (Nationally Determined Contribution) to the UNFCCC with a goal of reducing GHG emissions by 9% (using domestic resources only) and 27% (with international support) by 2030, compared to 2014.[1] The transport sector is a major contributor to GHG and air pollution in Vietnam, responsible for 18% of total national GHG emissions.[2] In NDC accounting, transport is subsumed under the energy sector, which seeks to reduce GHG by 5.5 % (domestic resources) and 16.7 % (with international supports) compared to 2014. The government also issued the *Directive on reinforcement of controlling air pollution* in January 2021 to reduce air pollution in the country (Directive 03/ CT-TTg).[3] This Directive requires many government agencies to take actions and establish collaborations to control air pollution and reduce its impact on the environment and on the population's health. To this end, the Ministry of Transport is required to create national programs on the development of environmentally friendly transport modes, including electric vehicles, and on the encouragement of their use.

Two-wheelers (motorcycles and mopeds, 2Ws) are the dominant transport modes in Vietnam, and play an essential role in meeting the travel demand of the Vietnamese

1 The previous NDC set target would have reduced GHG emissions by 8% (domestic resources only), and by 25% (with international support) by 2030 compared to 2010.

2 Jung Eun Oh, Maria Cordeiro., John Allen Rogers, Khanh Nguyen, Daniel Bongardt, Ly Tuyet Dang, & Vu Anh Tuan, *Addressing Climate Change in Transport-Volume 1: Pathway to Low-Carbon Transport*, (World Bank: Hanoi, 2019), https://openknowledge.worldbank.org/handle/10986/32411.

3 Directive 03/CT-TTg on reinforcement of controlling air pollution, Vietnam Prime Minister, January 18, 2021.

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people. Two-wheelers account for 93.3% of all national motorized vehicles.[4] In 2018, more than 58 million motorcycles and mopeds were registered in the country, and the two-wheeler ownership rate was approximately 615 vehicles per 1000 inhabitants,[5] compared to a car ownership rate of 38 vehicles per 1000 inhabitants.[6] The large two-wheeler fleet has generated significant challenges. Two-wheelers are the leading cause of many environmental problems in the country, especially air and noise pollution, and are responsible for the greatest levels of traffic emissions among transport modes because of their dominance in vehicle fleets, low emission standards, and lack of regulations regarding inspection and maintenance. According to a 2018 Ministry of Natural Resource and Environment report, as a share of total transport emissions two-wheelers are responsible for more than 90 % of CO and VOC (volatile organic carbon) emissions, and 60 % of suspended particle emissions.[7]

Electrification of two-wheelers is a promising approach to reducing two-wheelers' emissions and noise pollution, as they have zero tailpipe emissions and emit very low levels of noise. In addition, the number of electric two-wheelers (e2Ws) in the country is on the rise. In 2020, e2Ws accounted for 8.3% of total two-wheeler sales compared to 4.9% in 2019, demonstrating momentum for electrification of the two-wheeler fleet in the country.[8] Shifting from internal combustion engine (ICE) two-wheelers to e2Ws could also play an essential role in cutting GHG emissions, reducing air and noise pollution, mitigating climate change effects, meeting the net-zero emission target by 2050,[9] and building a more sustainable transport system in Vietnam.

This briefing reviews the existing policies, regulations, and standards related to two-wheelers in Vietnam; identifies gaps in policies, regulations, and standards that may hinder progress on electrification of two-wheelers; and provides recommendations to address these gaps. In addition, recommendations to reduce air pollution and fuel consumption of two-wheelers are also provided. The analysis also identifies the responsibilities of relevant agencies related to the electrification of two-wheelers.

2. DEFINITIONS AND CLASSIFICATIONS OF TWO-WHEELERS

The term "two-wheelers" in Vietnam commonly refers to bicycles, motorcycles, and mopeds. Motorcycles and mopeds have been defined in the technical regulations issued by the Ministry of Transport (MOT) (QCVN 14:2015/BGTVT).[10] **A motorcycle** is a motor vehicle with two or three wheels, a cylinder capacity of 50 cm^3 or greater, a maximum speed of more than 50 km/h, and net weight not exceeding 400 kg. **A moped** is a motor vehicle that has two or three wheels, a maximum speed not exceeding 50 km/h, and a cylinder capacity of not more than 50 cm^3 for the internal combustion engine, and not exceeding 4 kW for the electric motor. The **electric moped**

4 United Nations, "Road Safety Performance Review Viet Nam" (2018). https://unece.org/DAM/trans/roadsafe/unda/RSPR_Viet_Nam_FULL_e.pdf

5 Minh Duc,"Xe máy tại Việt Nam tăng 48 lần trong gần 30 năm," VTV News, April. 17, 2019,https://vtv.vn/trong-nuoc/xe-may-tai-viet-nam-tang-48-lan-trong-gan-30-nam-20190417154721 22.htm (In Vietnamese)

6 "Tổng hợp số liệu phương tiện giao thông trong cả nước," *Vietnam Register*, accessed 22 December 2021, http://www.vr.org.vn/thong-ke/Pages/tong-hop-so-lieu-phuong-tien-giao-thong-trong-ca-nuoc.aspx (In Vietnamese)

7 Ministry of Natural Resources and Environment (MONRE), "Báo Cáo Môi Trường Quốc Gia 2017 - Chuyên Đề: Quản Lý Chất Thải. Hà Nội, Việt Nam" (2018). (In Vietnamese)

8 Dinh-Son Tran, Huong Le, Zifei Yang, *Two-wheelers in Vietnam: A baseline analysis of fleet characteristics and fuel consumptions in 2019 and 2020*, (ICCT: Washington, DC, 2022), https://theicct.org/publication/2w-lvs-vietnam-asia-baseline-feb22/

9 Son.T, Van.H, Ha. H, ..., Huong,T, "COP26 Và Dấu Ấn Việt Nam", Nhandan, November 21, 2021, https://special.nhandan.vn/COP26_Vietnam/index.html (In Vietnamese)

10 QCVN 14:2015/BGTVT: National technical regulation on safety and environmental protection for motorcycles and mopeds, Vietnam Ministry of Transport, November 6, 2015.

is defined more precisely in Decree No. 100/2019/ND-CP[11] as a two-wheel vehicle operated by an electric motor with power not exceeding 4 kW and a maximum speed not exceeding 50 km/h. Currently, electric two-wheelers with motor power greater than 4 kW and maximum speed higher than 50 km/h are also trading in the market and are allowed to operate in traffic. However, there is no clear definition for this type of vehicle in the existing regulations and standards. In this briefing, this type of vehicle will be defined as an electric motorcycle.

In 2020, 91% of new two-wheelers sold in Vietnam were ICE motorcycles, followed by electric mopeds, at 7.1%. ICE mopeds and electric motorcycles accounted for smaller shares, at 0.7% and 1.2%, respectively.[12] Table 1 presents the classification of two-wheelers in Vietnam based on selected characteristics and requirements.

Table 1. Classification of two-wheelers in Vietnam

Characteristics	Bicycles (including e-bikes)		Mopeds (*)		Motorcycles	
	Conventional bikes	E-bikes	IC engine	Electric engine	IC engine	Electric engine
Cylinder capacity/ Electric engine power	n/a	≤ 250 W	≤ 50 cm^3	≤ 4 kW	> 50 cm^3	> 4 kW
Designed speed	n/a	≤ 25 km/h	≤ 50 km/h	≤ 50 km/h	> 50 km/h	> 50 km/h
Vehicle weight	n/a	≤ 40 kg	n/a	n/a	≤ 400 kg	n/a
Age allowed to drive	n/a	Non	≥ 16 years old	≥ 16 years old	≥ 18 years old	≥ 18 years old
Driving license required	n/a	n/a	n/a	n/a	Yes	Yes
Vehicle registration required	n/a	n/a	Yes	Yes	Yes	Yes
Helmet required	n/a	Yes	Yes	Yes	Yes	Yes

Note: n/a: not applicable; (*) The maximum operating speed on the roads for mopeds (including e-mopeds) is 40 km/h.[13]

Electric bicycles (e-bikes) are defined as two-wheeled bicycles operated with an electric motor or with a pedal mechanism assisted by an electric motor, with maximum motor power of 250 W, a maximum design speed (when operated by electric motor) not greater than 25 km/h, and vehicle weight (including the battery) of not more than 40 kg (Circular 66/2015/TT-BGTVT).[14] E-bikes and conventional bicycles do not need to be registered for use and produce no, or minimal, air pollution. Therefore, they are not included in the scope of this briefing. In addition, the number of three-wheelers is very small in the vehicle fleets, and using these vehicles is strongly restricted in the country (except for occasional cases such as use by handicapped veterans, and trash collection). Thus, three-wheelers are also not included in this paper. Two-wheelers in this briefing refer to motorcycles and mopeds only. The two-wheeler market in Vietnam has been dominated by foreign brands, including Honda and Yamaha. In 2020, 89.3% of two-wheelers sold in the country were from these two manufacturers.[15]

11 Decree No 100/2019/NĐ-CP: Decree administration penalties for road traffic offences and rail transport offences, Vietnam Government, December 30, 2019.

12 Dinh-Son Tran, Huong Le, Zifei Yang, *Two-wheelers in Vietnam: A baseline analysis of fleet characteristics and fuel consumptions in 2019 and 2020*, (ICCT: Washington, DC, 2022), https://theicct.org/publication/2w-lvs-vietnam-asia-baseline-feb22/

13 Circular No. 31/2019/TT-BGTVT Circular on speed and safety distance of road vehicles and heavy-duty vehicle in road traffic, Vietnam Ministry of Transport, August 29, 2019.

14 Circular 66/2015/TT-BGTVT: Amendment 1:2015 QCVN 68:2013/BGTVT on National Technical Regulation on Electric bicycles, Vietnam Ministry of Transport, November 6, 2015.

15 Dinh-Son Tran, Huong Le, Zifei Yang, *Two-wheelers in Vietnam: A baseline analysis of fleet characteristics and fuel consumptions in 2019 and 2020*, (ICCT: Washington, DC, 2022), https://theicct.org/publication/2w-lvs-vietnam-asia-baseline-feb22/

3. POLICIES, REGULATIONS, AND STANDARDS RELATED TO TWO-WHEELERS

In Vietnam, policies and regulations are issued in the form of laws, resolutions, decisions, decrees, circulars, technical regulations, and technical standards. Laws are issued by the National Assembly, and resolutions are issued by the Government and the National Assembly Standing Committee. Decisions can be issued by the Prime Minister and by Ministers, or heads of ministerial-level agencies. Other policies or regulations are promulgated by the Ministers or agencies below the ministerial level. This section reviews existing policies, regulations, and standards related to two-wheelers and especially e2Ws, to identify the policy gaps that need to be filled to support ongoing expansion of the e2W fleet.

3.1. TECHNICAL REGULATIONS AND TECHNICAL STANDARDS ON TWO-WHEELERS

Current status

In Vietnam, there are two types of standards applied to two-wheelers: technical regulations and technical standards. Technical regulations are developed and promulgated by the Ministry of Transport (MOT). Compliance with them is mandatory for new vehicles, to ensure vehicle quality, safety, and environmental protection. By contrast, compliance with technical standards is voluntary. All or parts of a specific standard become mandatory only when it is referenced in legal documents or technical regulations. Two-wheelers that do not comply with technical standards are still allowed to be traded in the market.

National technical regulations (QCVN)

Newly manufactured, assembled, and imported motorcycles and mopeds must comply with QCVN 14:2015/BGTVT (*National technical regulation on safety and environmental protection for motorcycles and mopeds*). Two-wheelers and their components must be designed in accordance with the technical specifications determined in this regulation. In addition, there are a number of technical regulations on specific components of two-wheelers, such as QCVN 37:2010/BGTVT (*National technical regulation of motorcycle and moped engines*), and QCVN 27:2010/BGTVT (*National technical regulation on fuel tanks of motorcycles and mopeds*). Manufactured, assembled, and imported two-wheelers that do not comply with the technical regulations are not allowed to be sold.

Regarding e2Ws, there are two technical regulations exclusively applied to these vehicles. QCVN 90:2019/BGTVT[16] and QCVN 91:2019/BGTVT[17] stipulate the technical requirements and safety inspections, and the quality of the electric motor and traction batteries, that apply to electric motorcycles and mopeds.

Technical standards (TCVN)

Technical standards on two-wheelers have been developed by the National Standard Technical Committee TCVN/TC22 on Road Transport Vehicles and promulgated by the Ministry of Science and Technology (MOST). Overall, the technical standards on two-wheelers have covered a wide range of aspects, from standards for requirements and test methods on motorcycle chains to standards for measurement methods for gaseous exhaust emissions of motorcycles during inspection and maintenance.

Electric vehicles (EVs) are becoming more popular in the country. Some technical standards related to EVs and e2Ws have been developed; these are presented in

16 QCVN 90:2019/BGTVT: National technical regulation on motor used for electric motorcycles and mopeds, Vietnam Ministry of Transport, November 11, 2019.

17 QCVN 91:2019/BGTVT: National technical regulation on traction batteries used for electric motorcycles and mopeds, Vietnam Ministry of Transport, August 1, 2019.

Appendix A. Subjects covered in these technical standards include rechargeable energy storage systems (RESS), test specifications and safety requirements for lithium-ion battery systems, lithium-ion cell testing and safety, vehicle safety specifications, vehicle operational safety, electrical safety, vehicle performance, and electricity consumption. These technical standards are essential to ensure the safety of using and operating e2Ws. However, none of these technical standards is mandatory in the legal regulations that deal with safety risks.

Recommendation

In general, large gaps exist in the technical regulations and technical standards that apply across the life cycle of e2Ws. For example, technical regulations and standards related to charging infrastructure, battery swapping systems, and e2W vehicle disposal and recycling of expired batteries/accumulators are not available yet. To support the entire supply chain and service chain for e2Ws, the government should consider the following regulatory updates.

- **Develop a separate national technical regulation on e2Ws** (including e-mopeds and e-motorcycles). Currently, newly imported, manufactured, and assembled e2Ws must comply with the same national technical regulation (QCVN 14:2015/BGTVT) on safety and environmental protection as ICE two-wheelers. However, QCVN 14:2015/BGTVT is designed primarily for ICE two-wheelers, while there are many differences between e2Ws and ICE two-wheelers. Hence, QCVN 14:2015/BGTVT may not be sufficient to ensure the safety and environmental protection performance of e2Ws. Therefore, developing a new national technical regulation specifically for e2Ws should be considered.
- **Develop comprehensive regulations and standards related to the safety of e2W users and other road users.** Some of the technical standards related to e2Ws, such as standards on vehicle safety specification, vehicle operational safety, and electric safety may strongly influence the safety of users and other vehicle users. However, none of these technical standards is mandatory in the legal regulations that deal with safety issues. Converting these technical standards to technical regulations to make them mandatory is essential to ensuring the safety of e2W users and other road users. In addition, new regulations related to other safety aspects of e2W users and other road users should also be developed.
- **Establish harmonized technical regulations and technical standards on charging infrastructure and battery swapping systems, and operate these facilities to ensure safety and interoperability of the systems**. Interoperability allows users to have seamless access to charging facilities regardless of their vehicle models. It also reduces the costs of providing and operating charging facilities and battery swapping services because different e2W manufacturers can cooperate in providing and operating these infrastructures and services.
- **Develop a set of regulations/standards** that specify clear and unified definitions, terminologies, and vocabularies related to e2W charging infrastructure, swapping systems, etc. to ensure uniformity in future regulations and standards. For example, clear definitions of charging infrastructure and battery swapping systems are still missing from the existing regulations and need to be added.
- **Develop the technical regulations and standards related to e2W vehicle disposal and recycling of expired batteries/accumulators.** The improper treatment of electric batteries or accumulators may affect the environment negatively. Developing technical regulations and standards will mitigate these negative impacts and may reduce the cost of producing batteries for e2Ws.

3.2. VEHICLE EMISSION STANDARDS

Current status

In Vietnam, newly manufactured, assembled, and imported motorcycles and mopeds must comply with Euro 2 emission standards from July 1, 2007 through 2016 (Decision No. 249/2005/QD-TTG),[18] and with Euro 3 emission standards (only for motorcycles) from January 1, 2017 (Decision No. 49/2011/QD-TTg).[19] The Prime Minister is responsible for regulating the roadmap of emission standards for two-wheelers and the Ministry of Transport (MOT) is responsible for regulating two-wheeler emission standards. QCVN: 04/2009/BGTVT (*National technical regulation on emission of gaseous pollutants from assembly, manufactured motorcycles, mopeds and new imported motorcycles, moped*), issued in 2009, regulated two-wheeler emissions and complied with Euro 2. QCVN 77:2014/BGTVT (*National technical regulation on the third level of gaseous pollutant emission for new assembled, manufactured and imported two-wheeled motorcycles*), issued in 2014, regulated two-wheeler emissions and complied with Euro 3. Table 2 presents Vietnam's motorcycle and moped exhaust emission standards. Imports of used two-wheelers into Vietnam has been prohibited since 2013. Therefore, these emission standards apply to new two-wheelers only.

To certify a two-wheeler, manufacturers need to conduct three tests: a Type I test, a Type II test, and an evaporative emission test. The Type I test verifies the average emission of selective gaseous pollutants in the urban area following pre-defined test cycles. The Type 2 test verifies the emissions of carbon monoxide at idling speed. Regarding the Euro 2 emission standard, the test cycle was ECE R47 for mopeds and ECE R 40 for motorcycles. For the Euro 3 emission standard, manufacturers can select either ECE R40 or the Worldwide Harmonized Motorcycle Test Cycle (WMTC).

Table 2. Emission standards of two-wheelers (Unit: g/km)

Emission standards	Implementation date	Vehicle category	Cylinder capacity/ Speed	Pollutants			Test Cycle
				CO (Carbon monoxide)	HC (Hydrocarbon)	NO_x (Nitrogen oxide)	
EURO 2	01.07.2007	Motorcycles	< 150 cm^3	5.5	1.2	0.3	ECE R 40
			>= 150 cm^3	5.5	1	0.3	
		Mopeds	< 50 cm^3	1	1.2 (*)		ECE R 47
EURO 3	01.01.2017	Motorcycles	< 150 cm^3	2	0.8	0.15	ECE R 40
			>= 150 cm^3	2	0.3	0.15	
			Vmax < 130 km/h	2.62	0.75	0.17	WMTC
			Vmax >= 130 km/h	2.62	0.33	0.22	

(*): HC + NO_x

Recommendation

To reduce air pollution of two-wheelers and to improve air quality, Vietnam should apply more stringent emission standards to ICE motorcycles. The country should develop a clear roadmap for strengthening two-wheeler emission standards and to quickly move toward the Euro VI-equivalent standards. Motorcycle emission standards in Vietnam are not yet world-class. Although the technical standard on motorcycle

18 Decision No. 249/2005/QD-TTg: Decision setting the roadmap for application of emission standards to road motor vehicles, Vietnam Prime Minister, October 10, 2005.

19 Decision No. 49/2011/QD-TTg: Decision providing the roadmap for application of exhaust emission standards to manufactured, assembled, and imported brand-new cars and motorcycles, Vietnam Prime Minister, September 1, 2011.

emission level 4 (equivalent to Euro 4) was issued in 2020 (TCVN 13062:2020), this standard is not mandatory, and Euro 3 is still applied to new motorcycles in the country. Other countries have adopted more stringent emission standards on two-wheelers and Vietnam can learn from their experiences. For example, India has adopted the BS IV emission standard on two-wheelers in 2016, and the BS VI standard (equivalent to the Euro VI standard) in 2020. Strengthening motorcycle emission standards for ICE motorcycles and quickly moving to Euro VI-equivalent standards in parallel with electrification progress could improve the country's air quality significantly.

3.3. VEHICLE FUEL QUALITY

Current status

Regarding vehicle fuels, the Ministry of Science and Technology (MOST) is responsible for regulating the National technical regulation on gasoline, diesel fuels, and biofuels. QCVN: 1:2015/BKHCN regulates the limits for technical standards, quality, safety, health, and environmental protection of vehicle fuels. In addition, MOST is primarily responsible for managing, measuring, and controlling the quality of produced, imported, and circulated fuels in the market. Ministry of Industry and Trade (MOIT) coordinates with the Ministry of Finance (MOF) and takes the main responsibility for regulating and managing fuel prices. In Vietnam, all new internal combustion two-wheelers are powered by gasoline and use the same gasoline as four-wheel vehicles. Table 3 presents the specifications of unleaded gasoline levels 2, 3, and 4 that complies with Euro 2, 3, and 4 in the country. MOST is developing technical regulations on gasoline, diesel fuel, and biofuels to comply with the Euro 5 emission standard that was expected to be available at the end of 2021. However, this regulation is still not available.

Table 3. Characteristics of gasoline in Vietnam

Characteristics	Unit	Level 2	Level 3	Level 4	Testing method
Research Octane Number	RON (min)	90/92/95	92/95/98	92/95/98	ASTM D 2699
Lead	g/L (max)	0.013	0.013	0.005	ASTM D 3237
Distillation					
10% vol evaporation	°C (max)	70	70	70	ASTM D 86
50% vol. evaporation		max 120	70-120	70-120	
90% vol. evaporation		190	190	190	
Final boiling point		215	210	210	
Residue		2	2	2	
Sulfur	mg/kg (max)	500	150	50	ASTM D 2622 or ASTM D 5453
Benzene	%v/v (max)	2.5	2.5	1	ASTM D 5580 or ASTM D 3606
Aromatics	%v/v (max)	40	40	40	ASTM D 1319
Olefins	%v/v (max)	38	30	30	ASTM D 1319
Oxygen	% m/m (max)	2.7	2.7	2.7	ASTM D 4815
Metal Content (Fe, Mn, etc)	mg/l (max)	5	5	5	ASTM D 3831
Visual appearance		clear, no layering, no impurities	clear, no layering, no impurities	clear, no layering, no impurities	ASTM D 4176

Recommendation

Fuel quality plays an essential role in reducing vehicular emissions. To reduce vehicle emissions, the government should support stronger national fuel standards. A tighter

mandate for < 50 ppm sulfur fuel would contribute to greater emission reductions because fuel with lower sulfur content results in lower emissions of particulate matter, regardless of vehicle technology.[20] Lower sulfur in fuels also enables the adoption of advanced emission control technologies in new vehicles, as well as increasing the efficiency of emission control equipment of vehicles currently on the road. In addition, strong penalties for non-compliant fuel suppliers should be enforced to reduce and avoid the making and trading of counterfeit fuel in the country.

3.4. VEHICLE FUEL CONSUMPTION LABELING

Current status

In 2017, the Prime Minister promulgated the Decision on the list of equipment and appliances to which the mandatory energy labeling and minimum energy-efficient standards are applied, along with the roadmap for implementation (Decision 04/2017/QD-TTg). Based on the Decision, displaying fuel consumption labels on newly manufactured, assembled, and imported motorcycles and mopeds is mandatory from January 1, 2020. Currently, the requirement is applied to ICE two-wheelers only. The information on vehicle fuel consumption has allowed people to select the most fuel-efficient vehicles that meet their needs and has increased demand for more fuel-efficient vehicles. Figure 1 displays an example of a fuel consumption label issued by the Ministry of Industry and Trade (MOIT). The fuel consumption test can be carried out independently or in combination with a type I test and conducted by the testing agency. Fuel consumption test results are issued by the testing agency. Manufacturers must send this report to Vietnam Register (VR), and VR publishes fuel consumption data on their website. Then, manufacturers must place the fuel consumption label on every vehicle before putting them up for sale. Vehicle energy labeling does not yet apply to electric vehicles.

Figure 1. Example of motorcycle fuel consumption label (photo taken by Son-Dinh Tran)

Recommendation

Energy labels are not required on e2Ws in Vietnam but this should change. Displaying energy efficiency in kWh/Km on e2Ws can provide the information needed to support customers in selecting the most efficient vehicles. An adequate test cycle needs to

20 Sarah Chambliss, Anup Bandivadekar *Opportunities to Reduce Vehicle Emissions in Jakarta,* (ICCT: Washington, DC, 2014), https://theicct.org/sites/default/files/publications/ICCT_Jakarta-briefing_20141210.pdf

be developed to carry out the test that measures the energy efficiency of e2Ws. Additional information should also be added to the label to reflect requirements specific to e2Ws (e.g., driving range, energy consumption). This will increase the profile of e2Ws and will be useful when priority measures (e.g., parking priority, lane usage priority) for e2Ws are implemented.

3.5. VOLUNTARY TECHNICAL STANDARDS ON FUEL CONSUMPTION

Current status

Technical standards governing the fuel consumption and fuel economy of two-wheelers are available and are complied with voluntarily. Technical standard TCVN 7356:2014[21] specifies the fuel consumption limit and fuel economy of two-wheelers and methods for their determination. ECE R 40 is used to measure the fuel consumption of motorcycles. Table 4 presents the fuel consumption limit and fuel economy of two-wheelers. Although the fuel consumption of the new two-wheeler fleet may be lower than the values described in Table 4, this standard may provide the basis for developing more stringent mandatory standards in the future.

Table 4. Limits on fuel consumption and fuel economy of two-wheelers

Engine displacement (cc)	Fuel consumption limit (l/100km)	Fuel economy (km/l)
<= 50	2	50
50 -100]	2.3	43.5
100 - 125]	2.5	40
125 - 150]	2.5	40
150 - 250]	2.9	34.5
250 - 400]	3.4	29.4
400 - 650]	5.2	19.2
650 - 1000]	6.3	15.9
1000 - 1250	7.2	13.9
> 1250	8	12.5

Recommendation

The Vietnamese government should develop mandatory standards on fuel consumption, fuel economy, and CO_2 emissions on two-wheelers. Several existing policies have been required to develop the fuel consumption standards on ICE two-wheelers in Vietnam. However, these standards are still unavailable. Mandated standards on fuel consumption or fuel economy of two-wheelers could give a clear signal to vehicle manufacturers and prompt the transition to a more efficient and lower-emission fleet. These standards will also help reduce consumer fuel costs and GHG emissions from more efficient ICE two-wheelers. In addition, this also makes e2Ws a viable technology pathway and paves the way toward the zero-emission transition in the long term.

3.6. TAXATION AND FEES RELATED TO TWO-WHEELERS

Current status

Table 5 presents the taxes and fees that are currently applied to two-wheelers in Vietnam. Five types of taxes and fees are assessed for owning and operating two-

21 TCVN 7356:2014: Technical standard on Road Vehicles-Two-wheeled motorcycles, mopeds—Limits of fuel consumption and method for determination, Vietnam National Standard Technical Committee TCVN/TC22 on Road Transport Vehicle, 2014.

wheelers: the registration fee, value-added tax (VAT), special consumption tax (SCT), vehicle license plate fee (paid once, at acquisition), and the mandatory civil liability insurance (paid annually). These taxes and fees are applied to both ICE two-wheelers and e2Ws. Incentive policies that encourage people to purchase and use e2Ws are not offered in Vietnam.

Regarding the registration fee, the tax rate is 2%, except for two-wheelers registered in centrally affiliated cities, in provincial cities, or in towns where the provincial People's Committee is based, in which case the rate is 5%. The registration fee is calculated based on vehicle price or on the registration price (regulated by the Ministry of Finance), whichever is higher. The taxes and fees described in Table 5 are applied to domestically manufactured and assembled vehicles only. The number of imported two-wheelers in Vietnam is relatively low, and most of the imported two-wheelers have a high engine displacement and are used mainly for recreation purposes rather than for daily travel.

Imported vehicles must pay additional taxes and fees (e.g., import tax, custom fee). Import taxes vary greatly depending on vehicle characteristics (e.g., engine displacement) and country of origin. Three import tax rates that may apply to two-wheelers are the normal tax (usually more than 100%), the preferential import tax (ranging from 40% to 75%), and the special preferential import tax. The preferential import tax applies to products originating from countries that have most favored nation trade status with Vietnam. The special preferential import tax applies to products imported from countries that have bilateral or multilateral trade agreements with Vietnam. For example, based on the Asian Trade in Goods Agreement (ATIGA), the import tax on two-wheelers produced from Asian countries has been 0% since 2018.

Table 5. Taxations and fees related to two-wheelers

Type of tax/fee	Payment period	Tax based	Tax rate	Regulated agency	Legal document
Registration fee	One-time	Vehicle price or based registration price, and registered area	5% in centrally affiliated cities, provincial cities; 2% in other areas	National Government	Decree No. 140/2016/ND-CP
Value-added tax (VAT)	One-time	Vehicle price + SCT (if any)	10%	National Assembly	Law No. 13/2008/QH12
Special consumption tax (SCT)	One-time	Vehicle price	20 % (applied for motorcycles with a cylinder capacity exceeding 125 cm3 only)	National Assembly	Law No. 70/2014/QH13
Compulsory civil liability insurance	Annual	Fixed	Mopeds: 55,000 VNĐ/year Motorcycles: 60,000 VNĐ/year	Ministry of Finance	Circular No. 04/2021/TT-BTC
Granting vehicle license plate	One-time	Vehicle price and registration area	Range from 50,000 VNĐ to 4 million VNĐ	Ministry of Finance	Circular No. 229/2016/TT-BTC

Recommendation

Currently, e2Ws are subject to the same taxes and fees as ICE two-wheelers. Providing incentives to potential buyers of e2Ws could significantly increase purchases of e2Ws, given that "high price" is one of the top three reasons given by

Vietnamese people for not buying EVs.[22] Providing financial incentives for owning and operating e2Ws—such as vehicle purchase subsidies, tax exemption or tax reduction, and lower electricity prices—could potentially increase the uptake of e2Ws. Experiences from many countries such as China, Netherlands, Denmark, the United Kingdom, and the United States have shown a positive correlation between fiscal incentives and EV adoption.[23] The Vietnamese government can learn from these countries and adapt their lessons to the local context to facilitate e2W uptake. In addition, establishing a CO_2-based taxation system could also incentivize the transition to low- and zero-emission two-wheelers.

3.7. OTHERS

In Vietnam, vehicle inspections are implemented only for newly manufactured, assembled, and imported two-wheelers. Regulations governing periodic inspection and maintenance of in-use two-wheelers are still absent, which explains the country's high level of emissions and noise pollution from two-wheelers. Regarding emissions, MOT is developing the action plan to control and reduce emissions of in-use two-wheelers (Decision 2060/QĐ-TTg).[24] In addition, several pilot projects have been implemented, such as for confiscating old and polluted vehicles, and for free vehicle inspections in some areas.[25] Two-wheelers are also a major source of noise pollution in the country, and exposure to high noise levels may cause adverse impacts on the population's health. However, actions to reduce noise emissions from two-wheelers are still limited.

At the city level, Hanoi and Ho Chi Minh City are planning to limit the operation of two-wheelers (excluding bicycles) in cities. Hanoi, for example, according to resolution No. 04/2017/NQ-HDND on the approval of the proposal *"Increase road vehicle management to reducing traffic congestion and environmental pollution in Hanoi, period of 2017-2020 and vision to 2030"*, the city will gradually restrict the usage and pursue a complete ban on two-wheelers by 2030. In 2021, the city government is developing a proposal to ban two-wheelers in several urban districts after 2025, and gradually to extend it to other parts of the city. However, there is no specific action plan on this issue and it has not been clear if the city also plans to ban e2Ws or not. The proposal of banning two-wheelers has received strong opposition from many experts and residents because the majority of the transport demand in these cities depends on two-wheelers, and public transport options are still weak.[26]

Besides actions to reduce air pollution of new registered two-wheelers and to accelerate e2W uptake, actions to reduce the air and noise pollution of in-use two-wheelers are also needed such as mandating periodic inspections and maintenance, and providing subsidies to drivers of older and high-polluting two-wheelers to eliminate these vehicles from the fleet.

22 Le Anh Tuan, Presentation *"Study on the criteria development of pilot city selection for e-mobility adoption in Vietnam"*, presented at NDC-TIA kick-off Meeting 15 March 2021, Hanoi, Vietnam, https://www.changing-transport.org/wp-content/uploads/3.-210312-NDC-TIA-kick-off-Vietnam_Le-Anh-Tuan_Consultant-team-leader.pdf

23 Zifei Yang, Peter Slowik, Nic Lutsey, Stephanie Searle, *Principals for effective electric vehicle incentive design. The International Council on Clean Transport*, (ICCT: Washington, DC, 2016), https://theicct.org/publication/principles-for-effective-electric-vehicle-incentive-design/

24 Decision 2060/QĐ-TTg: Decision approval of the National strategy on road traffic order and safety for period 2021-2030 and vision to 2045, Vietnam Prime Minister, December 12, 2020.

25 "Chương trình nghiên cứu thí điểm kiểm tra khí thải xe mô tô, xe gắn máy đang lưu hành trên địa bàn thành phố Hồ Chí Minh", Accessed December 20, 2021, https://vamm.vn/chuong-trinh-nghien-cuu-thi-diem-kiem-tra-khi-thai-xe-mo-to-xe-gan-may-dang-luu-hanh-tren-dia-ban-thanh-pho-ho-chi-minh/ (In Vietnamese)

26 Anh Kiet, D.Tung, "Hanoi to ban motorcycles by 2030", the Hanoi Times, December 2,2020, http://hanoitimes.vn/hanoi-prepares-conditions-to-ban-motorcycles-by-2030-315097.html

4. STRATEGIES SUPPORTING EV DEVELOPMENT

E2Ws generate much lower emissions and less noise than ICE two-wheelers. Shifting from ICE two-wheelers to e2Ws could play an essential role in cutting GHG emissions, reducing air and noise pollution, mitigating climate change, and furthering the development of sustainable transport in Vietnam. There have been several government policies supporting EV deployment in Vietnam, and key policies are described in Table 6. In general, four key national strategies are used to provide guidance for developing transport policies in Vietnam, including (1) the National Climate Change Strategy (Decision No. 2139/QD-TTg), (2) the National Sustainable Development Strategy (Decision No. 432/QD-TTg), (3) the National Green Growth strategy (Decision No. 1393/QD-TTg), and (4) the Environmental Protection Law (Law No. 72/2020/QH14). Based on these strategies, specific action plans are developed.

Deployment of EVs is still in the early stages in Vietnam. A comprehensive policy framework supporting EV deployment has not been developed. However, the EV revolution, pressure to cut GHG emissions, and support from the local EV industry have recently brought the topic onto policy agendas. For example, the Resolution on Orientation of National Energy Development Strategy issued in 2020 (Resolution No. 55-NQ/TW) requires that promoting electric vehicles be prioritized. And the Environmental Protection Law promulgated in 2020 (Law No. 72/2020/QH14) requires the government to develop preferential policies to promote low fuel consumption, low or zero-emission vehicles, and vehicles using renewable energy, and to develop the roadmap for transitioning and eliminating vehicles that use fossil fuel. In addition, the requirement to establish fuel consumption standards, and to regulate energy labeling for electric vehicles, are also included in several policies (Resolution No.140/NQ-CP, Decision 452/QĐ-BGTVT). Overall, policies listed in Table 6 are still general. Two major points mentioned through these policies are (1) promoting cleaner vehicles (including electric vehicles) and (2) developing fuel consumption standards for internal combustion vehicles. There are several policies that apply specifically to electric cars such as the Development strategy for Vietnam's automobile industry to 2025, vision to 2035 (Decision No. 1168/QĐ-TTg) and Amendment to some articles of the Law on VAT, the Law on SCT, and the Law of tax administration (Law No. 106/2016/QH13). However, policies specifically supporting e2W development do not exist yet.

Table 6. Government strategies favoring EV development

Legal document	Year issued	Name of document	EV-related contents
Decision No. 2139/QD-TTg	2011	National Climate change strategy	Promotes low-carbon emission vehicles
Decision No. 432/QD-TTg	2012	National Sustainable Development Strategy	Controls and reduces air pollution from transport activities
Decision No. 1393/QD-TTg	2012	National Green Growth strategy period 2011-2020 vision to 2050	Reduces GHG emissions, promotes cleaner vehicles
Decision No. 1168/QĐ-TTg	2014	Development strategy for Vietnam automobile industry to 2025, vision to 2035	Encourages the production of eco-friendly automobiles (including electric vehicles)
Law No. 106/2016/QH13	6/4/2016	Amendment to some articles of the Law on VAT, the Law on SCT, and the Law of tax administration	Introduces SCT, which favors EVs (applied for cars only)
Decision No. 985a/QĐ-TTg	1/6/2016	National action plan for air quality management to 2020, vision to 2025	Develops the mechanisms and policies on managing and promoting EVs, within MOT
Decision No. 2053/QD-TTg	18/10/2016	National action plan for implementing Paris Agreement	Mandates MOT to develop and implement the action plan for cutting GHGs in the transport sector to meet NDC targets
Resolution No. 55-NQ/TW	11/2/2020	Resolution on Orientation of National Energy Development Strategy to 2020, Vision to 2045	Prioritizes the effective utilization of all renewable energy resources and the development of a smart and efficient power grid); promotes electric vehicles
Resolution No. 136/NQ-CP	25/9/2020	Resolution on sustainable development	Promotes sustainable energy. Gives MOT responsibility for developing vehicle fuel consumption standards and encouraging the use of clean fuels
Resolution No.140/NQ-CP	2/10/2020	Resolution of the action plan for implementation Resolution No.55-NG/TW	Gives MOT authority to develop and apply fuel consumption standards; promotes clean vehicles (including EVs)
Law No. 72/2020/QH14	17/11/2020	Law on environmental protection	Develops preferential policies to promote low fuel consumption, low or zero-emission vehicles, and vehicles used renewable energy. Develops the roadmap for transitioning and eliminating vehicles that use fossil fuel
Directive No. 3/CT-TTg	18/1/2021	Directive on controlling air pollution	Authorizes MOT to develop national programs on developing and encouraging use of environmentally friendly transport modes, including electric vehicles. MOIT develops policies on exploiting, processing, and importing raw materials (lithium, …) for battery production of electric vehicles; and grid capacity to meet the demand of increase in EV in the future
Decision 452/QĐ-BGTVT	24/3/2021	MOT's action plan responds to climate change, enhances resource management and protects the environment over the period 2021-2025	Reduces GHG emissions in the transport sector; develops regulations on energy labelling for electric cars, hybrid cars, electric motorcycles, and motorcycles; promotes cleaner vehicles including EVs; develops the fuel consumption standards for passenger cars and two-wheelers

Although e2Ws could potentially reduce GHG from the transport sector and improve air quality in Vietnam, specific policies supporting e2W development are largely unavailable. Hence, to accelerate e2W deployment in the country, developing a comprehensive policy framework that promotes e2Ws is highly recommended. Following are recommendations for developing policies to accelerate e2W uptake in Vietnam:

» **Develop a roadmap for e2W adoption and a clear vision and target for e2W development.** This can effectively accelerate the e2W uptake in the country from both the demand and supply sides. The roadmap will encourage customers to buy e2Ws instead of ICE two-wheelers, accelerating e2W uptake. It will also encourage manufacturers to shift production from ICE two-wheelers to e2Ws. The 2W electrification roadmap could indicate the pathway toward certain electrification targets or even set ambitious targets like mandating e2W production and phasing out ICE two-wheelers in Vietnam.

» **Develop policies to support the e2W industry, its supply chains, providers and operators of charging infrastructure, and battery swapping services.** High production costs and low demand for e2Ws could prevent manufacturers from shifting to production of e2Ws. Therefore, strong government support is essential to promote EV industry development in the early stages. Designing and providing good incentive programs could strongly encourage manufacturers to produce e2Ws and their components. Examples of incentive policies include reducing the registration fee for locally manufactured and assembled vehicles; reducing import tariffs on parts and raw materials for manufacturing and assembling e2Ws; and providing direct subsidies to manufacturers of e2Ws and e2W parts. The local manufacturer (VinFast) and several other manufacturers have already shown the feasibility of introducing e2Ws to the market.[27] These supporting policies could provide a more e2W-friendly environment to encourage further investment in the e2W industry.

» **Develop policies to encourage e2W ownership and usage.** Policies should be designed to make owning and operating e2Ws more attractive to consumers, including making e2Ws cost-competitive and conducting public campaigns to raise awareness of the technology. In addition, other policies that favour e2Ws over ICE two-wheelers should also be developed (e.g., create zero-emission zones).

5. KEY STAKEHOLDERS INVOLVED IN ELECTRIC TWO-WHEELER UPTAKE

Transport policies and regulations related to two-wheelers, clean transport, electric vehicle deployment, and relevant government documents have been reviewed to determine the potential stakeholders and their roles in accelerating e2W adoption in Vietnam. The result is presented in Table 7 below. This table was developed based on reviewing the functions, duties, and powers of relevant stakeholders that are usually regulated by legal documents. The Prime Minister (or National government) is responsible for promulgating roadmaps of the transition from ICE two-wheelers to e2Ws, eliminating ICE two-wheelers, and developing policy incentives for manufacturing, owning, and operating e2Ws. The Ministry of Transport (MOT) takes the lead in creating the proposal on the roadmap for electrification of the two-wheeler fleet, elaborating a comprehensive technical regulation related to e2Ws (including vehicle technical regulations, vehicle operating and testing regulations, vehicle inspections and maintenance regulations, vehicle labeling, and technical regulations on vehicle components), and developing fuel consumption or fuel economy standards. Ministry of Finance (MOF) is responsible for developing the financial incentives for manufacturing, owning, using e2Ws, providing and operating charging infrastructure, and battery swapping services. Ministry of Industry and Trade (MOIT) takes the main role in developing and regulating the technical standards and regulations related to charging infrastructures and charging technologies for e2Ws.

Vietnam could use the support of research institutes, non-government organizations, and universities in developing technical regulations and standards, a roadmap for electrification two-wheelers, and fuel consumption standards to accelerate e2W deployment, reduce air pollution, and mitigate climate change impacts in the country. The potential stakeholders and their roles listed in Table 7 are relevant not only for e2Ws but for electric vehicles in general.

In general, accelerating the electrification of two-wheelers in Vietnam requires substantial support from technical regulations and technical standards and policies. Coordination and collaboration of different stakeholders, including public authorities, manufacturers, service providers, electricity companies, and research institutes are

27 Dinh-Son Tran, Huong Le, Zifei Yang, *Two-wheelers in Vietnam: A baseline analysis of fleet characteristics and fuel consumptions in 2019 and 2020,* (ICCT: Washington, DC, 2022), https://theicct.org/publication/2w-lvs-vietnam-asia-baseline-feb22/

necessary to cover different perspectives and to facilitate the smooth transition from ICE two-wheelers to e2Ws.

Table 7. Potential stakeholders and their roles in e2W adoption in Vietnam

Stakeholders	Responsibilities/Roles
The Prime Minister/National Government	Promulgate a roadmap for transitioning from ICE two-wheelers to e2Ws
	Promulge a roadmap for eliminating ICE two-wheelers
	Promulgate the policy incentives for manufacturing, owning, and operating e2Ws
Ministry of Transport (MOT)	Develop a comprehensive regulation related to e2Ws, including vehicle technical regulations, vehicle operating and testing regulations, vehicle inspections and maintenance regulations, vehicle labeling, and technical regulations on vehicle components (e.g., batteries, accumulators)
	Develop the fuel consumption or fuel economy standards for ICE two-wheelers
	Propose a roadmap for electrification of the two-wheeler fleet
	Develop the priorities for e2Ws when operating in traffic (e.g., zero-emission zones)
	Collaborate with MOIT to design and regulate energy labels for e2Ws
	Regulate driver training, driving tests, and issuance of driving licenses for e2W users
Ministry of Natural Resources and Environment (MONRE)	Regulate the collection, disposal, and recycling of expired batteries/accumulators used in e2Ws
	Undertake research on raw materials needed in the manufacture of electric vehicles (e.g., lithium, nickel, cobalt)
	Collaborate with the Ministry of Education, local authorities, and related agencies to raise public awareness of using e2Ws
Ministry of Finance (MOF)	Develop the financial incentives for manufacturing, owning, and operating e2Ws
	Develop the financial incentives for providing charging infrastructure, charging services, battery swapping services, and manufacturing e2W parts
	Develop financial incentives for processing and recycling e2W batteries, accumulators, etc.
	Collaborate with MOT and MOPS to regulate penalties for e2W users when they violate traffic rules
Ministry of Industry and Trade (MOIT)	Regulate the technical rules and standards related to charging infrastructure, charging technologies, and battery swapping systems for e2Ws
	Collaborate with electric two-wheeler manufacturers and related agencies in providing and managing charging infrastructure, battery swapping systems, and battery exchange stations
	Develop a roadmap for deployment of charging infrastructure and battery swapping systems related to e2Ws
	Regulate the energy policies related to e2Ws (including electricity prices)
	Ensure the supply of electricity sufficient to accommodate the increase in electric vehicles
	Collaborate with MOF to regulate fuel prices
Ministry of Science and Technology (MOST)	Stimulate the comprehensive technical standards related to e2Ws
	Regulate the technical dimensions of vehicle fuels and fuel quality standards
Ministry of Public Security (MOPS)	Provide special identification plates/signs for e2Ws and manage e2W registration information
Provincial People's Committee	Collaborate with related agencies to facilitate e2W deployment at the city level
Manufacturers of E2W and E2W parts	Collaborate with relevant Ministry to conduct R&D on manufacturing e2Ws
	Design, manufacture, and distribute EVs to end-users
Industrial associations (VAMM, VAMA, VASI, ...)	Support manufacturers in the transition to manufacturing e2Ws
	Support supply chains for manufacturing e2Ws
	Connect e2W manufacturers with government agencies
Research institutes, universities, NGOs	Support government in developing the roadmap for electrification of two-wheelers and the roadmap for fuel consumption standards for ICE two-wheelers
	Support government efforts to accelerate e2W uptake

VASI: Vietnam Association for supporting industries; VAMM: Vietnam Association of Motorcycle Manufacturers; VAMA: Vietnam Automobile Manufacturers' Association

6. SUMMARY

The paper has reviewed existing regulations, standards, and policies related to two-wheelers including ICE two-wheelers and e2Ws in Vietnam. The gaps in policies, regulations, and standards that hinder the electrification progress of two-wheelers are determined. Two-wheelers are major sources of GHG emissions and air and noise pollution in the country. Promoting e2Ws could potentially reduce GHG emissions from the transport sector and improve air and noise quality in Vietnam. However, the technical regulations and technical standards related to e2Ws, and specific policies supporting e2W development that could affect progress in the electrification of the country are largely unavailable. In the paper, we have provided recommendations to facilitate e2W deployment and reduce two-wheelers' emissions in Vietnam. Key recommendations are summarized here:

- Develop comprehensive regulations and technical standards related to e2Ws, charging infrastructure, battery swapping systems, and vehicle disposal and recycling of expired batteries
- Strengthen emission standards for ICE two-wheelers and quickly moving toward the Euro VI equivalent standards
- Regulate fuel consumption, CO_2 emissions, or fuel economy standards on ICE two-wheelers
- Develop stronger national fuel standards and early adoption of low-sulfur fuel
- Regulate the use of energy labels on e2Ws
- Develop the roadmap for the adoption of e2Ws
- Develop policies to support e2W industry, its supply chains, providers and operators of charging infrastructures and battery swapping services
- Develop policies to support and encourage the ownership and usage of e2Ws

APPENDIX A: TECHNICAL REGULATIONS AND TECHNICAL STANDARDS ON E2WS IN VIETNAM

Topic	Document	Title of the document
Vehicle	QCVN 90:2019/BGTVT	National technical regulation on the motor used for electric motorcycles, mopeds
	TCVN 12504-1:2020	Electrically propelled road vehicles - Safety specifications - Part 1: Rechargeable energy storage system (RESS)
	TCVN 12504-2:2020	Electrically propelled road vehicles - Safety specifications - Part 2: Vehicle operational safety
	TCVN 12504-3:2020	Electrically propelled road vehicles - Safety specifications - Part 3: Electrical safety
	TCVN 12773:2020	Electrically propelled mopeds and motorcycles - Safety specifications
	TCVN 12776-1:2020	Battery-electric mopeds and motorcycles - Performance - Part 1: Reference energy consumption and range
	TCVN 12776-2:2020	Battery-electric mopeds and motorcycles - Performance - Part 2: Road operating characteristics
Battery	QCVN 91:2019/BGTVT	National technical regulation on traction batteries used for electric motorcycles, mopeds
	TCVN 12241-1:2018	Secondary lithium-ion cells for the propulsion of electric road vehicles - Part 1: Performance testing
	TCVN 12241-2:2018	Secondary lithium-ion cells for the propulsion of electric road vehicles - Part 2: Reliability and abuse testing
	TCVN 12241-3:2018	Secondary lithium-ion cells for the propulsion of electric road vehicles - Part 3: Safety requirements
	TCVN 12241-4:2018	Secondary lithium-ion cells for the propulsion of electric road vehicles - Part 4: Candidate alternative test methods for the internal short circuit test of IEC 62660-3
	TCVN 12503-1:2018	Electrically propelled road vehicles – Test specification for lithium-ion traction battery packs and systems – Part 1: High-power applications
	TCVN 12503-2:2018	Electrically propelled road vehicles –Test specification for lithium-ion traction battery packs and systems –Part 2: High energy applications
	TCVN 12530-3:2018	Electrically propelled road vehicles – Test specification for lithium-ion traction battery packs and systems – Part 3: Safety performance requirements
	TCVN 12774: 2020	Electrically propelled mopeds and motorcycles - Test specifications and safety requirements for lithium-ion battery systems
Charging cables	TCVN 12671-1:2019	Charging cables for electric vehicles of rated voltages up to and including 0,6/1 kV - Part 1: General requirements
	TCVN 12671-2:2019	Charging cables for electric vehicles of rated voltages up to and including 0,6/1 kV - Part 2: Test methods
	TCVN 12671-3:2019	Charging cables for electric vehicles of rated voltages up to and including 0,6/1 kV - Part 3: Cables for AC charging according to modes 1, 2 and 3 of IEC 61851-1 of rated voltages up to and including 450/750 V
Connection to external electric power supply	TCVN 12772:2020	Electrically propelled road vehicles - Connection to an external electric power supply - Safety requirements
	TCVN 12775:2020	Electrically propelled mopeds and motorcycles - Safety requirements for conductive connection to an external electric power supply