

A Few Problems with the Electric Charging Station Design for Vietnam's Urban Road Network

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Abstract. Many different types of electric cars are currently in circulation on the urban road network in Vietnam. However, there are currently a few problems with the urban road network of electric charging stations constructed in Vietnam's urban areas, including the location layout not being connected to traffic planning and urban infrastructure planning, the station design charging in accordance with foreign standards, not taking into account Vietnam's traffic conditions, and the inappropriate fire safety. The lack of standards and technical requirements for the construction of electric charging stations in the urban network in our nation currently presents a significant disadvantage to the implementation of policies aimed at converting electricity use. The authors' article presents some criteria for the design of electric charging stations suitable for urban road network, current urban traffic flow characteristics in Vietnam.

Keywords: Electric charging stations, urban roads, electric cars, urban traffic lines.

1 Introduction

Vietnam is one of the five nations most impacted by climate change, which is a serious global challenge. In order to combat climate change, the Vietnamese government is dedicated to reducing greenhouse gas emissions and advancing sustainable development. Vietnam made a resolute commitment to reduce net emissions to "zero" by 2050 at the 26th Conference of the Parties to the United Nations Framework Convention on Climate Change (COP26), joining 147 other nations. To gradually implement the commitments made at COP26, the Prime Minister signed Decision 876/QĐ-TTg on July 22, 2022, approving the Action Program on green energy transformation and carbon emission reduction, as well as transportation industry methane. Specific goals, roadmaps, and tasks have been identified for each field, with road transportation and the development of electric vehicles being the primary focus. This is reflected specifically in Decision 876: Period to 2050: "to make a drastic transformation of all means, equipment, and transportation infrastructure to electricity use. and green energy" [1].

To reduce environmental pollution, we are focusing on developing cars that do not use fossil fuels in the current development trend of the automobile industry in the world and in Vietnam. Electric cars have been and continue to be the transportation

trend of the future, as well as green traffic. Vinfast, a Vietnamese company, has introduced personal cars and electric buses to the market. These vehicles have been seen on the roads of Vietnam's major cities. However, one issue is that charging stations for electric vehicles currently lack adequate Ministry of Transport and related agency standards, regulations, and guidelines. This will make the planning, arrangement, and design of electric charging stations on Vietnam's road network and urban roads more difficult. The period 2022-2030 is clearly stated in Decision 876/QD-TTg: "...developing electric charging infrastructure to meet the needs of people and businesses" [1]. This demonstrates that the problem of technical factors for the power charging station system is an urgent one that will necessitate future collaboration between scientists and regulatory agencies. In this study, the author proposes the design of one electric charging station in urban Vietnam using the data analysis method from previous research.

2 Cars use electric power and problems related to the technical elements of electric charging stations

Electric vehicles use energy generated by electric motors rather than internal combustion engines powered by fuels such as gasoline or diesel. Electric vehicles run on energy from a rechargeable battery pack. Pure electric vehicles are automobiles that run entirely on electricity (EVs). Furthermore, a hybrid electric vehicle is a vehicle that can run on both electricity and other fuels (HEV). In Vietnam, the VinFast company has been a pioneer in "paving the way" for the recent surge in the popularity of electric vehicles. Until now, electric vehicles have only been tested on the Vietnamese road network. Some VinFast electric vehicles currently in operation in Vietnam such as Vinfast VF e34, Vinfast VF8, Vinfast VF9 and VinBus' electric bus (Figure 1).



Fig. 1. Some electric cars of Vinfast (Source: vinfast.vn).

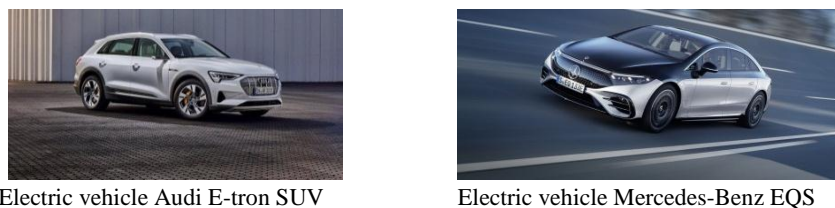


Fig. 2. Some other electric cars (Source: thanhvien.net).

Furthermore, electric vehicles imported into Vietnam from global automakers are available in the Vietnamese market such as Electric vehicle Audi E-tron SUV, Electric vehicle Mercedes-Benz EQS, MG Marvel R Electric and Electric vehicle Mitsubishi Airtrek 2022 (Figure 2).

The basic dimensions of electric cars manufactured by Vinfast are given in Table 1 [2]:

Table 1. Basic dimensions of electric cars of Vinfast company

Parameter	Vfe34	VF7	VF8	VF9
Length ,m	4.3	4.545	4.45	5.12
Width, m	1.768	1.89	1.9	2.0
High, m	1.53	1.636	1.66	1.721

Currently, different electric vehicle manufacturers use various types of batteries in terms of capacity and charging time. This causes issues for vehicles traveling on the road network because charging stations must meet certain specifications in order for the vehicle to enter the charging station.

Some factors related to electric cars and electric charging stations:

- Battery capacity will affect charging time at the charging station;
- The geometry of the vehicle affects the location and size of the charging station;
- Distance between charging station and surrounding works in fire prevention and fighting according to current regulations;
- General geometric dimensions of the charging station and the geometry of the charging station entrance and exit segments connected to the common road;
- Position arranged to wait for people on the vehicle during charging at the station;
- Layout position, and geometric size of the power supply for the station.

There are also some other factors such as landscape, the distance between stations, and signs.

From the above influencing factors, we make the following observations.

Electric cars are an unavoidable trend in the development of green road vehicles in Vietnam in the future. There are currently many different types of electric vehicles on Vietnam's road network. As a result, charging stations must meet the technical requirements of the aforementioned electric vehicles.

3 Research on some technical factors of electric charging stations in traffic and urban conditions in Vietnam

3.1 Electric charging station status at the present time

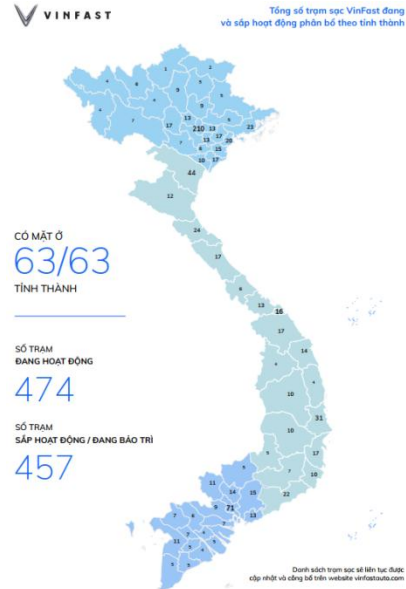
Currently, many charging stations have been built in Vietnam's urban areas. Vinfast is the company that creates these charging stations. VinFast's charging stations were present in 63/63 cities and provinces across the country by June 13, 2022 (Figure 3) [2].

The charging stations are currently arranged in three ways: independently in urban apartment buildings (basement, on the exploitation land of the building); independently located in commercial centers and residential areas; and arranged at rest stops and gas stations on roads.

There are some issues to discuss in relation to the layout positions. Prior to the current situation, there were no standards, regulations, or guidelines for the design or operation of the charging station.

- There is no classification of charging stations: charging stations need to be classified according to the amount of electricity consumed or the number of vehicles entering the station or the type of vehicles entering the station or the level of fire protection.

- Details of the fire zoning in relation to nearby vehicles or structures. The organization of traffic for the vehicle entering and exiting the charging station is related to the geometrical dimensions of the station.



The network of charging stations of Vinfast company until June 13, 2022

Fig. 3. Vinfast's charging station [2].

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3.2 Give some recommendations for electric charging station requirements

According to [3], [10] who provide us with a number of issued standards. There are currently quite a few charging station standards in the fields of electricity and electronics. Some international standards (figure 4):

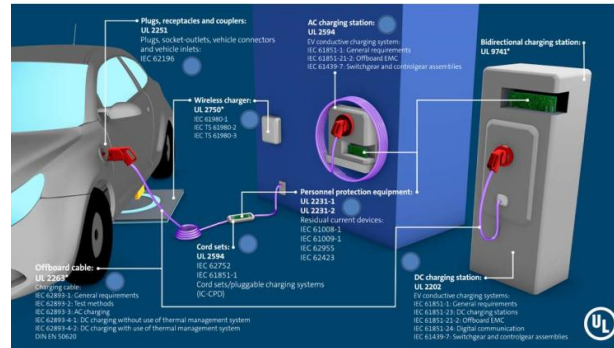


Fig. 4. Some International Charging Station Standards [10].

Some Vietnamese standards such as TCVN 13078-1:2020; TCVN 13078-21:2020; TCVN 13078-23:2020; TCVN 13078-21-2:2020; TCVN 13078-24: 2022; TCVN 13510: 2022; TCVN 12671-1:2019; TCVN 12671-2:2019; TCVN 12671-3:2019. Other items that use foreign standards, such as IEC, include power consumption and charging support equipment, electrical installation systems for charging stations, plugs, and connectors (charging head, charging gun). Continue to research and develop standards for personal protective equipment in charging stations, electrical cabinets and panels, and electrical installation systems from charging stations to the grid in the coming years.

Despite numerous studies on standards in the fields of electricity and electronics for charging stations, many parameters still need to be improved. There are currently no standards, regulations, or guidelines in the field of traffic and road network research.

In fact, there are still some shortcomings in the location arrangement around the world and in Vietnam. Many locations in newly constructed public buildings were not included in the approval of the land fund for the arrangement, resulting in numerous objections from the public while the charging station was being built. In India, there was a fire at a charging station that burned nearly 100 cars [4].



Fig. 5. Fire at a charging station in India [4].

Analyze and recommend some technical parameters for electric charging stations.

Distance between charging stations: The distance between charging stations varies depending on many factors, including the vehicle's battery capacity for maximum travel, the route's terrain, the vehicle's power supply capacity, electric vehicle traffic on the route, charging post-type system suitable for all-electric cars, etc. Current reality and global experience show that the author proposes [7], [8], and [9] to suit Vietnam. Charging stations will be installed at existing rest stops along expressways. At the same time, if there are no rest stops on new routes, the average distance between stations will be set at 80 kilometers (the current average battery capacity for electric vehicles is 200km for a single charge). Because of the very limited land fund in Vietnam's urban road network, the station layout in urban areas must be considered specifically for each route.

Fire and explosion safety distance arrangement: the arrangement is associated with taking into account the risk of fire and explosion when charging the vehicle at the station. Because there is currently no regulation in Vietnam, the author refers to [11] to suggest the distance depicted in Figure 6.

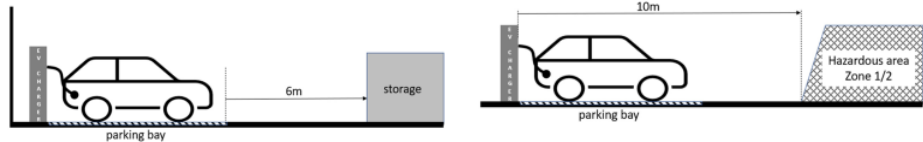


Fig. 6. Minimum fire safety distance [11].

Geometric size for a charging station position: the size $L \times B$ (length and width) of a current charging station in Vietnam is not specified. However, countries around the world have size restrictions based on the type of vehicle and charging station. Table 1 depicts the vehicle sizes currently in use in Vietnam. Because the sizes of the vehicles are similar, the author recommends using world sizes. Refer to the following sizes according to country [6] (Figure 7):

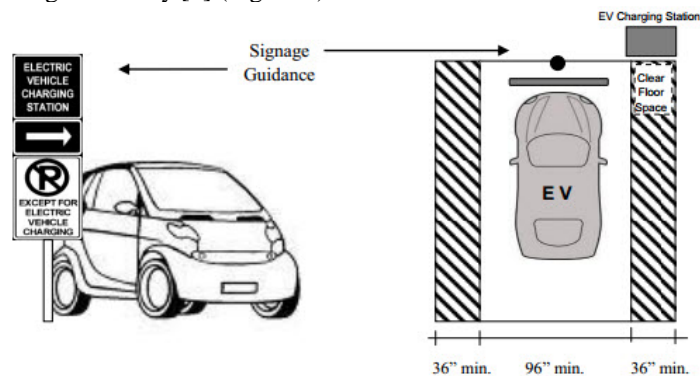


Fig. 7. Layout geometry dimensions in Texas (USA).

Choose the recommended size for use in Vietnam: width $B = 3\text{m}$, length $L = 5.6\text{m}$, and distance between charging cells $b = 0.3\text{m}$.

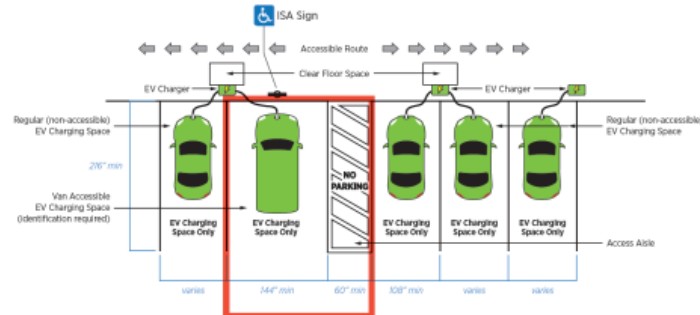


Fig. 8. Geometric dimensions of layout in California (USA) [5].

Signs and safety strips for vehicles when entering the charging position. There are currently no regulations on signs for electric charging stations, according to Regulation 41:2019/BGTVT. Currently, some types of signs are being used around the world [12], as shown in Figure 9.

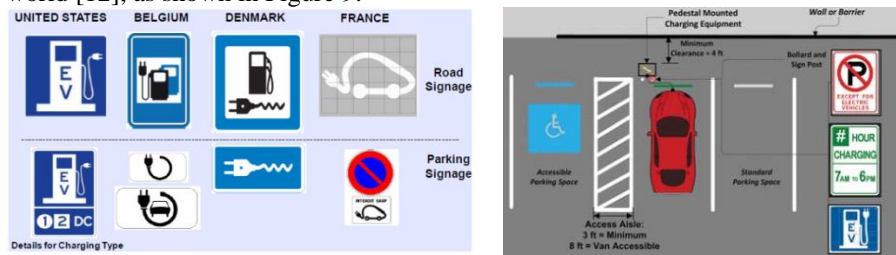


Fig. 9. Some signs and their placement in different countries [12].

Proposal to apply signs currently applied in US cities [12]. In addition to the proposed parameters, there are a number of other parameters that require additional research to suit the traffic and conditions of Vietnam, such as landscape, lighting, and common space... for electric charging stations.

4 Proposal to design electric charging stations in urban areas of Vietnam

The authors completed the basic design of a station for the Hoang Quoc Viet route in Hanoi. Currently, there are no charging stations along the Hoang Quoc Viet route. On the other hand, this is a route with high traffic density, high volume, wide road width, and a lot of lands that can be used to set up electric charging stations. Based on this fact, the authors propose constructing an electric charging station at the Ho Chi Minh National Academy of Politics. This location has a large open space towards Hoang Quoc Viet Street, which is currently the Academy's parking lot. The surrounding buildings' working space will not be impacted if a fence is built to separate them. In terms of safety, the distance is also adequate for construction.



Fig. 10. Expected location of charging stations (source: google map).

The author proposes that the geometric size of the L x H charging station be 3.0m x 5.6m based on the above analysis. The charging station, which has two charging posts, is located on Hoang Quoc Viet Street. While waiting for the charging vehicle, each charging station provides a rest area with snack service and sanitation facilities. In addition, arrange garbage collection locations and landscaping that is appropriate for the overall landscape. Make plans to construct fire-resistant walls with a minimum safety distance of 6m. Specific images of the charging station are shown in Figures 11 and 12.

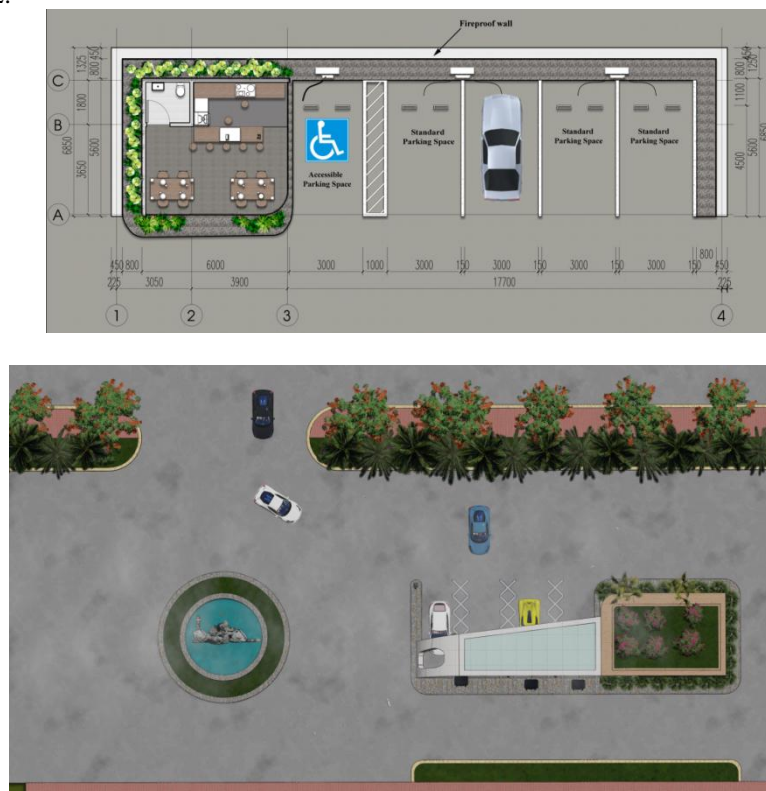


Fig. 11. Plan of charging station.



Fig. 12. Charging post layout and landscape.

5 Conclusions

Designing and arranging electric charging stations for cars that use electric energy is a major issue in today's urban traffic towards green traffic in Vietnam's major cities.

As soon as possible, state management agencies must develop a system of synchronous standards and regulations for the planning, design, and operation of electric charging stations appropriate for Vietnam's traffic and urban conditions.

Continue to research electric charging station models appropriate for Vietnam's conditions based on global experience in building charging stations.

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