Challenges for Electric Vehicle Adoption in Bangladesh

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Abstract—Electric Vehicles (EV) are adding new dimension in the transportation sector as well as consuming huge electric power. Although, it becomes very popular due to numerous benefits such as- limits fossil fuel consumption, increases the environmental sustainability through low GHG emission, less sound pollution and cost-effective transport medium. However, EV adoption in Bangladesh becomes very challenging due to several barriers. This paper aimed to explore the potential factors that will be the challenges for EV adoption in the context of Bangladesh. In this paper, EV penetration is studied using SWOT analysis. In addition, this paper recommends several policies to overcome those challenges of EV penetration.

Keywords— Electric Vehicle (EV), SWOT analysis, Renewable resources, Electric Vehicle Charging Station

I. INTRODUCTION

The global automobile industry is slowly but surely moving towards electric vehicle. Transport industries basically dominated by the internal combustion engine which is now replacing by the electric vehicles. Mainly three types of EVs are available in the world i.e. Hybrid electric vehicle (HEV), Plug-in-Hybrid Electric Vehicle (PHEV), and Battery Electric Vehicle (BEV). Among of these EVs BEV is mostly used in Bangladesh. BEVs are propelled by an electric motor that uses the power from battery. BEV has required no fossil fuel and provides less emission than HEVs and PHEVs [1]. EV penetration is happening not only in the developed countries but also in developing and under developing countries. EV penetration require large amount of power which creates a huge pressure on the power grid, distribution networks.

Almost all the electric vehicles (i.e. Easy bike, auto-rickshaw and electric bike) in Bangladesh are run by battery. A study showed that, more than 0.5 million EVs are running in Bangladesh and these ingest 450 MW electric power daily from the national grid [2]. Batteries are charged through a charger from the ac power. The charger is a non-linear equipment which hampers the power quality through production of harmonics, voltage fluctuation etc. When large number of chargers is connected with the distribution networks, the power quality problem arises [3]. Thus, the impact of EV charging should be analyzed.

At first, this type of battery run EV was produced in china but now-a-days its developed in Bangladesh. Many small, medium and large industries are developing such vehicles. Also, people can buy this vehicle at cheap rate than earlier which is now about 1 lakh 20 thousand. With the rapid increase of EVs, the requirement of accessories & charging stations for EVs are increasing significantly. The charging station which is an important parameter seems not to be sufficient according to the demand. Thus, the electric vehicle owner recharges the batteries into their house with the residential tariff. In this regard, the power sector is fallen into system loss and the significant amount of earnings from this sector is missing [4]. The EV in Bangladesh has no clear statistics. Thus, the government cannot take proper action regarding this issue. There are different types of element associated with the EV adoption in Bangladesh. Such as- insufficient EV charging station (EVCS), battery technology, unavailability of power supply, high cost of charging, environmental pollution etc. Several studies were performed on barriers of EV penetration in different regions. However, there is no study is observed in the context of Bangladesh for EV adoption. It is the major source of motivation for the authors to do the research on this issue.

In this paper, the key barriers for adopting EV at a large scale in Bangladesh are analyzed using SWOT analysis. Finally, several policies are recommended to alleviate them.

II. CURRENT STATUS OF ELECTRIC VEHICLE AND ITS CHARGING INFRASTRUCTURE

EV adoption for a sustainable transportation to replace the fossil fuel & lesser the GHG emissions are major advantages. However, in terms of technical sense, increasing electricity demand, power quality disturbances by producing harmonics, transformer power losses and voltage disturbances are the major problems in Bangladesh. In Bangladesh, electric vehicle like auto-rickshaw, electric tri-cycle and electric bike are using now-a-days. Electric auto-rickshaw and electric tri-cycle consumes 8-11 kWh per day for traveling 70-100 km. In the other case, electric bike consumes 1-2 kWh for 30-50 km. The battery of this auto-rickshaw takes 6-8 hours for full charging whereas electric bike battery takes 3-5 hours for full charging. Almost all the cases, the EV uses lead acid battery for operation.

According to the statistics of BRTA up to March, 2018, number of registered vehicle in Bangladesh is shown in Table 1. Table 1 shows that, auto-rickshaw vehicle

penetration is just 7.28% of the total vehicle. However, it is not obvious.

Table 1: Number of registered vehicle in Bangladesh [5]

Type of Vehicle	Number of vehicles	Percentage of total vehicle
Motor cycle	21,45,659	62.75%
Private car	3,35,660	9.81%
Auto-Rickshaw*	2,49,091	7.28%
Truck	1,35,081	3.95%
Pick up	1,05,159	3.07%
Microbus	98,175	2.87%
Jeep car	54,437	1.59%
Taxi cab	45,231	1.32%
Bus+ Minibus	72,336	2.11%
Others	1,79,055	5.23%

As of late, it is known to all that rapid increase of EV needs lot of charging station. However, charging stations are inadequate. Charging station provides charging arrangement of battery. In Bangladesh there are two types of charging station running. One is public another one is private. Public charging stations are very insufficient viz-a-viz private charging stations are available. Fig.1 shows the charging profile of an EVCS located in Gazipur, Bangladesh.
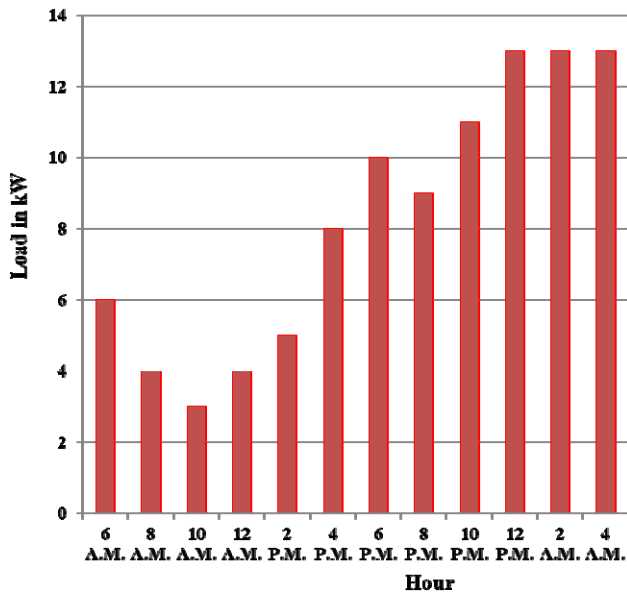

Fig.1: Load profile of an EVCS in Gazipur.

In city areas where the EV parking is not possible for every owner, they can park it during night time & lunch time in private stations. Charging stations categorizes according to the capacity, number of charging points and charging time & cost. With the appropriate use of charging stations in Bangladesh, government can earn additional revenue and also it will increase the opportunity for decreasing unemployment.

According to the technology used, charging station may be classified as follows. Such as- grid based charging station and renewable solar based charging station. The charging stations provide full charging of battery by BDT.100-120.

III. MODELING OF ELECTRIC VEHICLE CHARGING STATION

Growing popularity of EVs due to several positive impacts is admirable but its detrimental impacts on the grid power quality cannot be neglected. EVCS consists of the following parts basically- transformer, rectifier and converter etc. A model of EVCS is shown in Fig. 2 below. The transformer steps down the voltage level for the distribution purposes. Rectifier converts AC electricity into DC and the DC-DC converter regulates the DC power supplied to the EV battery.
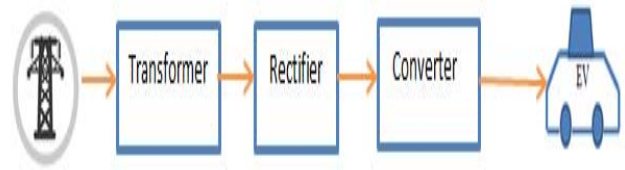

Fig. 2: Scheme for grid to EV integration.

Power demanded by an EVCS can be determined as the equation (1) below.

$$P_{EVCS} = \frac{P_{EV} * N_i * K_{O.L}}{\cos\theta};\qquad(1)$$

Where P_{EV} is the individual maximum power absorbed by an EV, N_i is the number of slot for EV connection and $K_{O.L}$ is the overload factor and $\cos\theta$ is the power factor [6]. In case of EV battery, minimum SOC has taken as 30% and maximum SOC is taken as 70%. The difference between EV arrival and departure time at EVCS is called duration of charging (t_D). B_C denotes battery capacity.

$$P_{EV} = \frac{B_C * (SOC_{max} - SOC_{min})}{t_D};\qquad(2)$$

IV. CHALLENGES OF ELECTRIC VEHICLE CHARGING STATION

Mass adoption of EVs is eventually reliant on consumer's readiness to purchase the technology. Mainly the EV consumers count on several factors when taking a decision to accept EVs. It includes price, range, robust and battery life. Although the numbers of EV are increasing but it will not be sustainable and profitable if the several factors are keeping untreated. There are several obstacles for EV adoption in Bangladesh which are described in this paper.

A. Shortage of power supply/load shedding

Bangladesh has a great electricity demand where only 67% of the people get electricity access. According to the BPDB, there are 25,26,594 electricity consumer has served demand of 10,958 MW power on 30 June 2018 [7]. The difference between maximum demand and the supply, the load shedding occurs in different areas of Bangladesh. The power loss due to the auxiliary use at generating station, transmission & distribution networks is around 9%. Thus the supply and demand cannot fulfill and load shedding arises. The daily load curve for Bangladesh electricity sector is given in Fig. 3. The load curve shows that, the load increases in the peak hour period (5 P.M. to 11P.M.) whereas it was minimum at off-peak hour (11 P.M. to 5 P.M.). However, the increased electricity demand causes by electric vehicles add an extra pressure to the grid especially at peak-hour period. It creates a great problem for minimizing demand and load-shedding occurs. Electric auto-rickshaw and tri-cycle mainly run at villages, upazila and small cities in Bangladesh. In these places, load shedding occurs frequently in a day. Thus, the shortage of power supply hampers the electric vehicle charging [8].
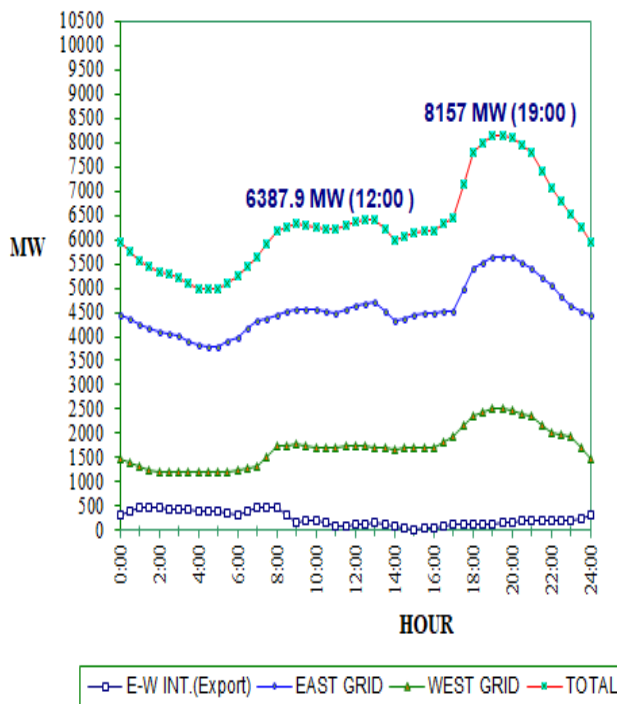

Fig. 3: Load Curve [7].

B. Lack of charging stations

One of the major difficulties for EV adoption is insufficient charging infrastructure. To promote EV adoption, there should have a lot of charging stations throughout the all corners of Bangladesh. However, these charging stations are very unsatisfactory.

Almost all the charging stations are private and they have taken higher rate for EV charging. Also, the national grid is under pressure for such type of EV charging demand especially at peak hour [9]. There is a problem of finding free space for EV charging anytime due to long queue. Thus, the *EV* owner has to wait. It kills the time which also drops the income of the EV driver. Recently there is a trend in power sector to establish some public charging stations throughout the country. For an example, BREB established 6 EVCS based on solar energy in Gazipur, Dhaka, Sylhet and Chittagong. DPDC also established 21 kW solar EVCS in keranigonj, Dhaka. These are the positive signs and hope for the charging stations in Bangladesh.

C. Battery charging affects power quality issues

Battery is the main component of an EV from where it takes the required power. The AC power is converted into DC power using a converter/charger which is a non-linear load. This nonlinear load affects the power system by producing various problems such as- harmonics, current and voltage unbalance, voltage sag and swelling, flickers and phase shifting. When EVs are connected for charging their batteries in a network, it produces harmonics and voltage & current fluctuation [10, 11]. Thus the power quality falls and it's a hindrance of EV penetration in Bangladesh.

D. Battery price and capacity

There are several types of battery lead-acid, lithium ion, Ni-Cd, Zn/air, Ni-Zn, Ni-MH, Na/S batteries. In Bangladesh, lead acid batteries are popular due to its low cost.

Although lead acid batteries have a number of drawbacks such as- it cannot discharge more than 20% of the rated capacity, low power density, heavy weight, lower life cycle etc. However, lithium ion batteries are advantageous over lead acid batteries such as- high power density, long life time, good performance at higher temperature etc [12]. Lithium ion batteries have few disadvantages like high cost, recharging takes large time. Ni-Cd battery has long battery life, fully dischargeable, recyclable but it's costlier in case electric vehicles. Another problem of using Ni-Cd battery, it pollutes the environment when not disposed properly. NiMH batteries have double energy density than lead acid battery.

E. High charging cost and time

EV adoption depends on another great factors that are cost & hours of charging. In Bangladesh, everyday 120 to 150 BDT is required for full charging of electric auto-rickshaw/easy bike. There are also different tariffs for EV charging which is increasing every year. In addition, this charging takes 6 to 8 hours daily. Thus, it's a big problem that deals with the shrinkage of the EV adoption.

F. Battery life time, maintenance and technology/material used

Mass adoption of EV depends upon the battery life time, costing and maintenance. These batteries are very much costly and life time is not so long. Thus the electric vehicle owner has to change it periodically. EV adoption can be increased if the battery technology & their performance is improved [13]. Although some of the batteries can recover their performance by maintenance.

G. Low EV speed

Most of the EV running in Bangladesh has a problem regarding speed. People are eagerly waiting for the techno logy which can solve these problems. EVs in Bangladesh have a speed on average of 20 km/hour. This low speed deteriorates the chance of mass EV deployment in Bangladesh.

H. Frequent accident

Now-a-days, it is seen everywhere in Bangladesh that due to EVs road accident happens frequently. As there is no separate road for these vehicles exists and the EV drivers are not much experienced in driving, road accident happening every day.

I. Lack of government support

According to the government of Bangladesh, using of EV is prohibited and government discourages to use these EVs. As these EV consume a huge amount of electricity, it is a burden on the power sector. EV has no clear database and registration procedure. However in recent observation, there are number of EV charging station running in different corners of Bangladesh on behalf of the power sector. Thus the lack of government support, it is difficult to deploy EVs in a higher penetration [14].

J. Non-licensed vehicle

There are no rules for registering electric vehicle in BRTA. But there should be a legal framework for promoting sustainable environment through energy efficient method of EV use.

The rules and regulations for electric vehicle licensing should be designed by technical and some other means as like motorized vehicle. As the electric vehicle is unlicensed vehicle as per government indication, it acts as an obstacle for EV penetration in Bangladesh [15].

K. Low range for single charging

The range problems in electric vehicle discourage it to use. Almost, all electric vehicles have range on average 60-80 km on full charging. Thus, after traveling this distance it requires to recharge the batteries. So, long distance traveling would be hampered using these EVs.

L. Quality of road

Electric vehicle should require smooth and healthy road for transportation. As it is sure that maximum portion of the EVs are used in rural areas where road transportation system are not healthy with a lot of disturbances. Thus, mass EV penetration would require high quality road for safe and smooth running.

V. SWOT ANALYSIS

SWOT analysis is a strategic planning system that can be used for categorizing strength, weakness, opportunities and threats. It is an important tool for determining the barriers existing in Bangladesh for increasing EV adoption. Fig. 4 shows the SWOT analysis for EV adoption and determines the barriers of EV acceptance in Bangladesh.

Strengths
1. Environment friendly due to less GHG emission.
2. Low O&M cost
3. Reduce the dependence on foreign oil imports
4. Easy to drive
5. Energy efficient transport medium

Weakness
1. Limited range and low speed vehicle
2. High charging time
3. Battery need to change periodically
4. Low consumer awareness
5. Frequent road accident

Opportunities
1. Increase employment opportunities
2. Availability of low cost labor
3. Improvement in battery technology
4. Integration of renewable resources for charging
5. Rising fuel prices
6. Greater opportunities for research & development
7. Rising awareness on environmental sustainability

Threats
1. Lack of government support
2. Available competitors in EV manufacturing
3. Lack of charging stations
4. Insufficient spare parts relative to general vehicle
5. Non-licensed Vehicle
6. Poor roads & traffic conditions

Fig. 4: SWOT Analysis for EV Adoption.

VI. Policy Recommendations for EV Adoption

Although electric vehicle has a huge demand of electricity and most of the times power sector falls into a problem with shortcomings of profit. In other cases, the electric vehicle has several positive impacts on environment, fossil fuel reduction, improved socio-economic status of EV owner and decreases the unemployment. To become sustainable in power sector, it is very urgent to increase the EV penetration in Bangladesh. Analyzing challenges of EV adoption, authors suggest few recommendations for increasing it. The recommendations are given below.

- ❖ At first, electric vehicle i.e. auto-rickshaw, electric bike, electric bi-cycle, electric tri-cycle needs registration in the national website. When it is completed then the total number of charging station required in different corners of Bangladesh can be easily calculated. Charging rate of EVs should be selected according to the energy consumption.

- ❖ As an environment friendly vehicle and cheapest mode of transportation, government should prioritize this vehicle. It can be done by applying no tax on accessories of the electric vehicle, establishing more charging infrastructure. Locations of charging stations need to be situated at a suitable place where transportation is easy & known for all. Also charging stations should be far away from distribution transformers for avoiding power loss & distortion.

- ❖ As the maximum number of EV chargers are connected at grid simultaneously, it affects the power quality issues by producing harmonics, voltage fluctuation etc. Coordinate charging scheme can be helpful for charging EV to reduce power quality problems.

- ❖ To cut pressure on the national grid via EV charging, the huge potentiality of renewable resources such as-solar, biogas and wind should be utilized. Few Solar based Charging stations are already established in different corners of Bangladesh by the government. These charging stations are designed to charge 20 to 30 EVs per day. The Government has set a tariff BDT. 40 to BDT. 50 for recharging easy bike and electric rickshaw respectively. As the solar can provide power only at day time and is absent in cloudy& foggy days, thus hybrid system (such as solar, biogas or solar, wind) is mandatory for sustainable production of electricity for EV charging [16].

- ❖ Vehicle to Grid (V2G) technology is required to EV management for proper utilization of renewable resources and also for improving efficiency [17]. Thus, excess energy will be used effectively.

- ❖ The EV owner should use updated battery technology. Also, battery management system should be used to monitor SOC when charging for avoiding overcharge. In Bangladesh, maximum EV owner uses lead-acid batteries. However, lithium ion batteries are more efficient and have higher life cycle than lead acid batteries. In addition, lead acid batteries are more vulnerable to the environment due to disposal of lead. Thus, it is necessary to use lithium ion batteries instead of lead acid batteries.

- ❖ Grid based charging station produces more CO_2 emission than charging station based on renewable energy [18]. Thus, the in case of considering lower GHG emission by EVCS renewable based charging station is necessary for increasing sustainable EV adoption.

- ❖ The used batteries of EVs can be used for backup and load leveling purposes. The used batteries when no longer usable in EVs, their residual capacity still has significant value. During off-peak hour, the excess electricity generation can be stored using these batteries. In addition, the EV owner earns some extra money by selling these batteries. The battery recycling policy developed by the government will help environmentally and financially.

- ❖ Training facilities should be provided by the government institution to the EV driver for better performance and safe driving management. For this purpose, BRTA can arrange training & workshop facilities.

- ❖ In case of highway, there should be separate lane for electric vehicles to decreasing frequent road accident. Also, the quality of the road especially for rural areas should be improved. Due to awkward, low quality & damaged road causes road accident and more energy consumption for electric vehicles.

- ❖ The government should encourage establishing more research center on these types of transportation vehicle for improving technology. Such type of research center can help to extend range of electric vehicles as well as enhancing battery capacity.

- ❖ Finally, awareness should be grown up by publishing the environmental benefits of using electric vehicles can help more adoption in Bangladesh.

VII. Conclusion

Prominent features of less environmental pollution & cheapest mode of transportation makes EV market more attractive to the consumers. However, due to some reasons EVs could not satisfy the consumer's demand. These issues are demonstrated in this paper in the context of Bangladesh. In this paper, challenges of electric vehicle penetration in Bangladesh are analyzed based on SWOT analysis. Also, the authors suggest some advices for increasing EV penetration based on technological, financial, policy and market aspects. As it is known that, the transport vehicles are increasing day by day. Thus, vehicular emission is also increasing abruptly. If the acceptance of EV is not well

established in the transportation market, then the environmental pollution will increase at an extreme level. So, it is necessary to convey the summary of the present paper to accept EVs and improve its penetration level over the conventional vehicle.

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