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EFFECTS OF POWER QUALITY ISSUES ON ELECTRIC VEHICLE CHARGING

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Abstract- Electric Vehicles (EV) are restricted contrasted with ordinary vehicles yet in not so distant future, the EV will be expanded in wide very soon. The EV markets expand due to the decrease of non-renewable energy source usage. The EV majorly affect the force brace and appropriation networks and because of the results of enormous pressure to energize the batteries. When coordinating with the utility matrix, substantial amount of charging station of EV influences the voltage and finally influences the quality. In Bangladesh the effect of electric vehicle charging station on power grid and appropriation networks is dissected as far as force request, sounds, Voltage droop and expand furthermore, transformer power misfortune. In this paper,the moderation procedure for lessening power quality unsettling influences is dissected.

Index terms: Power quality ,EV charging,EVCS,BEV,PHEV

1.INTRODUCTION

In the transportation area Electric Vehicle is nearly a new idea. The EV turns out to be a lot of alluring presently now a-days because of few advantages say, less natural contamination, less expensive method of transportation. There are for the most part three kinds of electric vehicle accessible in altogether like Module crossover electric vehicle (PHEV), Hybrid electric vehicle (HEV) and Battery electric vehicle (BEV). Utilization of EVs say Easy bicycle, auto-cart and electric bicycle are likewise expanding quickly and more than 7.28% of the all out enrolled vehicle until March 2018 in Bangladesh [1].These vehicles utilizes electric engines to run with the energy from batteries. As per the paper, EV infiltration requires more than 450 MW of power every day in Bangladesh [2]. The colossal force request makes a major issue with the current interest. To charge the EV it requires high force and enormous time yet their range isn't acceptable. Also, no adequate charging station is there in Bangladesh. Along, the battery needs to be charged from private association by the EV proprietor which turns into a reason for framework misfortune in the influence area. To advance EV infiltration, it is important to set up adequate charging stations situated at different appropriate spots [3].The EV batteries could work from a single or three phase supply framework. However, three phase supply system furnish bigger force along with quick charging. The nonlinear trait of EV charger could deliver current harmonics and the voltage gets influenced over the force network [4]. High non-straight stacking could be a reason for non-linear drop in voltage and accordingly voltage waveform may be mutilated. Again, non-direct burden can influence the exhibitions of transformer by expanding power misfortunes in the winding and consequently decreasing its influence yield [5]. Accordingly, EV chargers if coordinated to the power

framework or dissemination organization, it hampers the force quality. The force circulation network with the effect of EV is dissected by MATLAB simulink in this paper. This paper illustrates voltage and harmonics alongside the misfortunes of dissemination transformer while over-burdening with EV chargers.

2. EV REFILLING STATION

In Bangaladesh Electric vehicle charging is unquestionably insufficient. Charging stations are both public and private. In Bangladesh the charging stations installed by government are fewer yet most outrageous charging stations installed are private. Charging rates are high provided by these private charging stations. Square chart of an EVCS is depicted in Fig.1. Basically, a charger comprises rectifier and converter for EV charging. The specifications of EVs open in Bangaladesh are listed in Table 1.

Table 1: Electric Vehicle specifiactions in Bangladesh

AUTO RIKSHAW and EASY BIKE	ELECTRIC MOTOR CYCLE
Power: 500 W-1000 W	Power: 1000 W
Voltage: 36/48/60 V	Voltage: 48/60 V
Battery: 120 Ah-130 Ah	Battery: 14-25 Ah
Charging time: 6-7 hours	Charging time: 6-8 hours
Max. speed: 30-40 km/h	Max. speed: 50-80 km/h
Driving distance: 60-100 km	Driving distance: 40-60 km

As the loads due to EVs are expanding step by step in a fast way hence subsequently the effects of EVs ought to be investigated. In Fig.2 the effect of mass EV entrance on power framework is communicated. Despite the concept that EV entrance has least expensive transportation framework, lower GHG outflow office, keen lattice offices. In any case, negative effects on power framework network are a lot of critical.

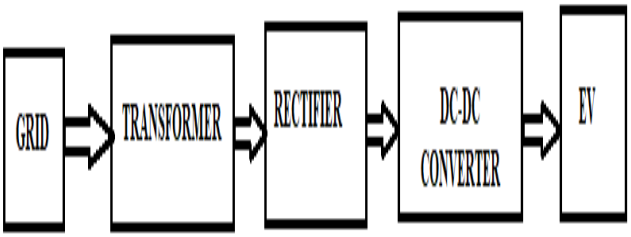

Fig.1: Block diagram of an EV Charging Station.

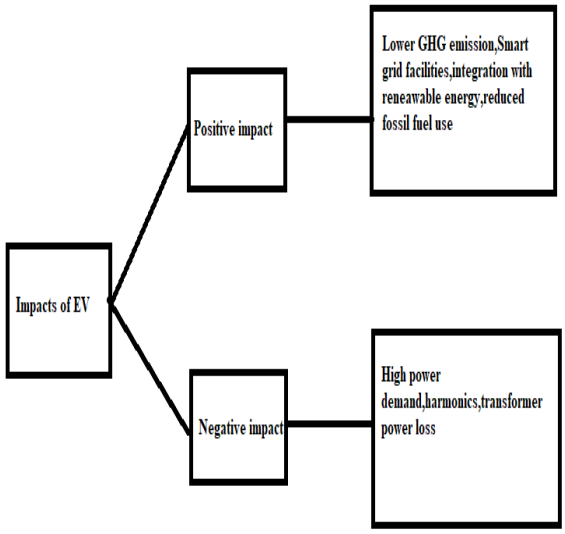

Fig. 2: Impacts of Electric Vehicle.

3. MATHEMATICAL MODELING

Sounds, poor voltage profile and force misfortune in appropriation transformer for non linear loads are produced by EV charger. Level 2 sort AC charging plot is utilized for EV charging where maximum current rating is 16A and most extreme force rating is 3.3 kW in Bangladesh. The power rating rating of electric vehicles are in the range of 0.5 kW to 1 kW for single phase 240 V, 50 Hz supply . In this paper, numerical displaying for sounds, voltage profile and overloading of transformer due to EV charging have been developed.

3.1.Demand of Power

From the power distribution system the charge is taken by the EV battery. The stability of the system is affected by the increased power demand because of non-linearity. The power demand of EV can be expressed as ,

$$P_{EV} = C_{Batt} * (SOC_{max} - SOC_{min}) / T_D \quad \text{----------(1)}$$

Where

C_{Batt} – battery capacity

T_D –Duration of charging

the summation of individual power demand, all things considered is the EV net power demand is, which probably implies as in Equation (2).

$$P_{gross} = \sum_{N=1}^{N} P_{EV} \quad \text{----------(2)}$$

3.2. Harmonics

The voltage and current rise in high frequency segments shall be contrasted with crucial frequency is characterized as sounds. Music contorts the voltage and current waveforms and in this manner influencing power quality. It very well may be estimated by complete symphonious contortion (THD) of current and voltage.

$$THD_i = \frac{\sqrt{\sum_{n=2}^{N} I_n^2}}{I_1} \times 100\ \% \quad \text{----------(3)}$$

$$THD_v = \frac{\sqrt{\sum_{n=2}^{N} V_n^2}}{V_1} \times 100\ \% \quad \text{----------(4)}$$

The Total harmonic distortion for current and voltage are expressed by the equation 3 and 4 respectively. THDi, THDv for slow charging will be comparatively less than the fast charging. Thus, harmonics will be produced by the EV with low SOC will produce harmonics.

3.3.Voltage profile

The voltage profile with low value turns into an undermining issue actuated by charging of EV. Voltage dependability alludes the capacity that the network of power being steady after the unexpected increment or decline of the loads.Huge measure of power are taken by EV loads at a brief term. Subsequently, voltage profile will be debased and matrix will be flimsy.

3.4. Performance of Transformer

Bulk sending of EVs makes an additional weight on the life cycle of distribution transformers. In addition, the rate of EV charging ought to be restricted each day and

for lessening power misfortune the charging stations should be away from transformer. Symphonious current cause load misfortunes in transformer while symphonious voltage causes no load misfortune. Due to these symphonious misfortunes, warming is expanded comparative with the unadulterated sinusoidal wave. This withstand capacity of symphonious can be estimated by k-factor.

K-factor $=\sum_{n=1}^{N} n^2 \left(\frac{I_n}{I_R}\right)$ ----------(5)

The nth harmonic current is In and the appraised load current is IR. Overheating in the transformer is caused due to the presence of harmonics .In this way, based on higher harmonic current withstand capacity for non-linear loading the transformer ought to be chosen [7].

4. IMPACT OF ELECTRIC VEHICLE CHARGING

The capacity of a power lattice organization to provide a maintainable and sinusoidal wave shape, commotion free inside the standard furthest reaches of voltage and current sounds is power quality. The normal issues identified with power quality are harmonics, voltage list/expanding.The parts that causing these issues when associated with matrix are the EV chargers. In Bangladesh the EV appropriation isn't just gives its negative effects yet additionally have a few positive effects. In this paper, we have examined just the negative effects.

4.1.Power Demand

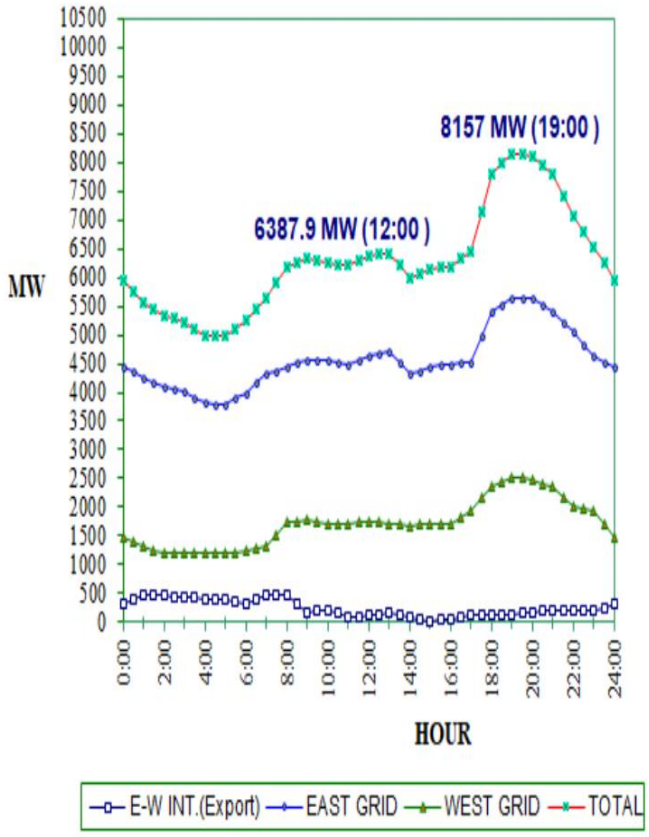

Fig.3: Load curve [8]

An additional strain to the framework add due to the expanded power request caused by electric vehicles. From the examination, it is observed that day by day 300-500 MW electric power is required . Fig 3 shows the day by day load bend for Bangladesh power area. The charging profile for EVs in a charging station is described in Fig 4. From the fig 4,the interest of EV charging increments at the hour of pinnacle hour. Consequently, the colossal interest during top hour taking all things together corners of Bangladesh for bulk entrance of EV prompts

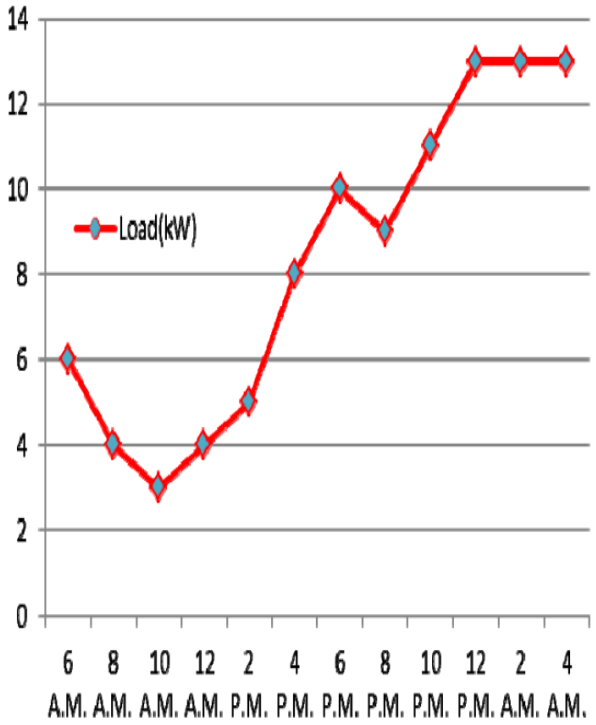

Fig. 4: Charging profile of an EVCS

Load shedding and furthermore hampers of power quality due to the expanded power request. During the event when EV charging is booked and keep up carefully at top and offpeak period, at that point the issue emerges with limited power interest.

4.2. Distortions due to Harmonics

The power framework aggravates due to harmonics. The non-linear burden EV charger when associated in the power framework produces harmonics. The total impacts of sounds can be danger for the entire power framework as the EV charger typically associated at the power conveyance network for charging. Fig. 5 (a), (b) and (c) shows the MATLAB Simulink of the sounds created at the extraordinary proportion of EV charging.

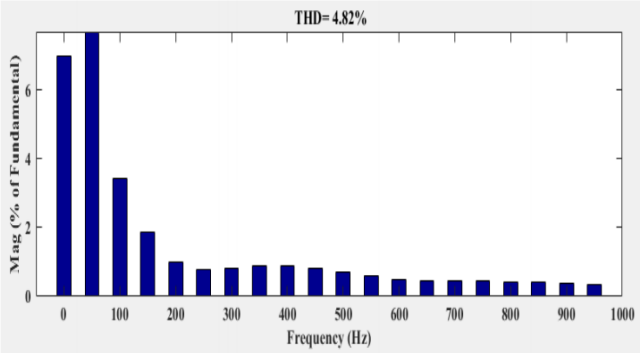

Fig. 5 a) Harmonics due to single EV connected at a charging station

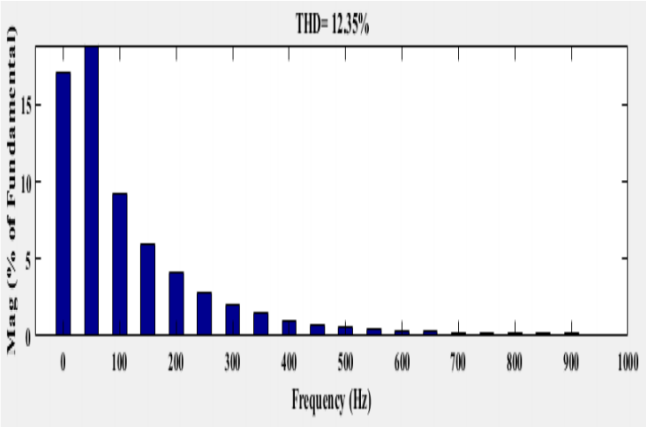

Fig. 5 b) Harmonics due to 3 EV chargers are connected at a charging station

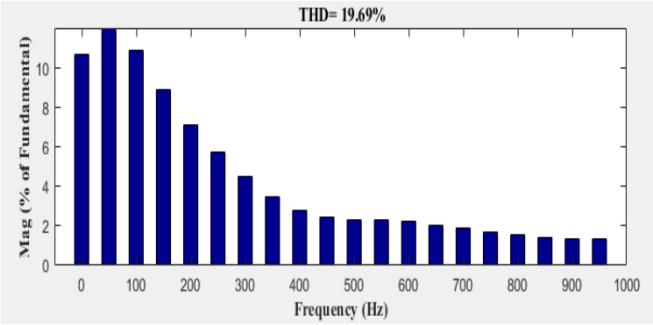

Fig. 5 c) Harmonics due to 5 EV chargers are connected at a charging station

As per the IEEE 519 THD ought to be beneath 5% for up to 69 kV power organization.This paper proposes that the EV chargers are associated with the matrix and

dissemination organization and the symphonious unsettling influences will be higher. For single EVs the THD is about 4.82%, THD for three EVs is about 12.35% furthermore, for five EVs with various determinations about 19.69%.

4.3. Power loss in Transformer

Transformer over-burdening may be due to bunched EV charging and in this manner expanding the power misfortune. Table 2 provides the over-burdening situation of a circulation transformer with diverse EV load. Warming misfortunes in transformer center which further builds the general power misfortune and diminishes the kVA rating of the transformer due to the symphonious current.

Table 2:Output of Transformer at different EV load

Output kVA under Rated current	Output kVA under Rated Harmonic current
200	191.80(1 EV)
200	186.75(3 EV)
200	181.45(5 EV)

By choosing transformer with higher k-factor the transformer power misfortune because of symphonious impacts can be limited. More the EVs associated to the dispersion transformer, the misfortunes will be more and along these lines the effectiveness of the framework of power gets diminished.

5.POWER QUALITY PROBLEM MITIGATION TECHNIQUE

An undermining factor for the power framework soundness al is the aggravations found in the MATLAB recreation. In this manner the power quality aggravations ought to be limited all together to get energy security and proficiency in power area. Bangladesh has an incredible possibility on sustainable assets like sunlight based and biomass, to defeat these power quality obstructions such sort of assets combination for EV charging can be an incredible answer [9]. Sun oriented illumination profile for various urban communities of Bangladeshis shown in Fig. 6. It shows that, Bangladesh is able enough to guarantee power age utilizing sunlight based assets.

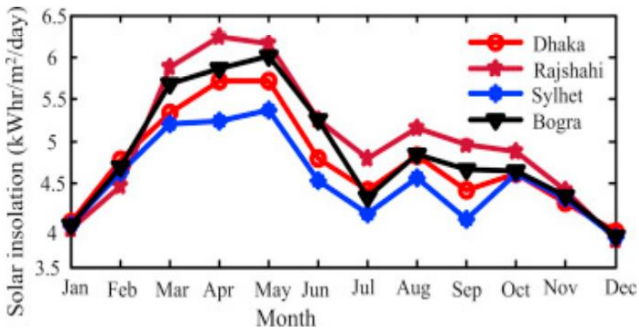

Fig. 6: Solar irradiation Profile [10].

In Bangladesh few hours in a day have access to sun oriented energy. At shady, hazy climate and furthermore around evening time, this energy is missing. Then again, In Bangladesh biomass assets like cow manure, poultry droppings and civil strong waste (MSW) are accessible [11]. Hence, the crossover power age conspire like sunlight based and biomass can be a successful answer

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for conquer these difficulties for charging EV [12].The charging of EVs are done from mixture dependent sustainable based charging station, at that point the utility matrix won't endure from the abundance energy needed for the EV charging particularly at top hour. Overall, utility matrix relieves the dangers like power quality issues. EV charges from non-sustainable assets discharges more GHGs than inexhaustible assets from another research performed on GHG outflow said that [13]. Thus, environmentally friendly power based EV charging plan would be a more prominent one for improving power quality with lower GHG discharge

6.CONCLUSION

As most extreme charging of EVs are done at private association because in Bangladesh charging stations are absent and due to this the power area has been neglected to procure the benefit from this area. However, because of certain reasons EVs infiltration makes power framework more helpless and power quality gets hampered. The power quality problems like harmonics, voltage variance, transformer power misfortunes are examined utilizing MATLAB Simulink in the setting of Bangladesh power area in this paper. Furthermore, the oderation strategy utilizing accessible inexhaustible assets is additionally talked about in this paper. Albeit the EVs have enormous benefits as like balancing out the network at under stacked condition, lower GHG emanation yet the power quality issues ought to control appropriately for manageable development in the power area.

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