POWER QUALITY ISSUES WITH HIGH PENETRATION OF ELECTRIC VEHICLE CHARGING IN DISTRIBUTION NETWORK

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(159318B)

Degree of Master of Science

Department of Electrical Engineering

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Dissertation submitted in partial fulfilment of the requirements for the degree Master of Science

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DECLARATION

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V. G. C. Priyanka

The above candidate has carried out research for the Masters Dissertation under my supervision.

Signature of the supervisor: Date

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ABSTRACT

Electric vehicles (EV) are becoming the most preferred and rapidly growing mode of transportation all around the world. Development of battery technologies and attention on residential scale renewable energy based distributed generation has accelerated the growth of the EV market. Commercial EV is equipped with energy storage, where a rechargeable battery is the most common type. EV Chargers are located either on board or off board. These chargers are present in different power levels. A regulated DC current shall be supplied to EV charging and the charging current is higher compared to conventional loads. Power electronic converters are used for the AC DC conversion thus a distorted current is drawn by the nonlinear load. This will give rise to power quality issues such as voltage unbalance, voltage fluctuations and harmonics on distribution systems. This research studies and quantifies the power quality impacts of the EV chargers on the distribution system. A detailed power electronic model of a commonly available EV charger is modelled in Matlab and a comprehensive current harmonic analysis is carried out in a standard IEEE LV distribution test feeder. The research focuses on the impact to the feeder with different EV penetration levels as well as different spatial load distribution. From the analysis it was determined for random EV distribution up to 40% of EV penetration is acceptable to the existing feeder at off peak intervals while only 30% is acceptable under nominal load condition as per IEEE 519 limits. If the EV chargers are clustered together, the current harmonic impact is higher and only 20% of EV penetration will be acceptable prescribed limits. The outcome of the research can be successfully used by distribution grid operators to determine to acceptable limits of EV penetration in the existing system. An algorithm encompassing the results of the study shall be employed in coordinated charging of electric vehicles where the operators shall dispatch the EVs based on the feeder loading and spatial distribution of EVs. Encompassed

(Key words – Electric Vehicle, Matlab modelling, Power Quality, Harmonics, LV distribution system)

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A	Ampere
CAN	Control Area Network
EV	Electric Vehicle
FFT	Fast Fourier Transform
HV	High Voltage
IEC	International Eelctrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineers
LV	Low Voltage
MV	Medium Voltage
NEC	National Electric Code
PCC	Point of Common Coupling
PI	Proportional Integral
PHEV	Plug in Hybrid Electric Vehicle
PV	Photo Voltaic
PWM	Pulse Width Modulation
SAE	Society of Automotive Engineers
TDD	Total Demand Distortion
THD	Total Harmonic Distortion
V	Volt