IMPACTS OF MAXIMIZING PLUG-IN ELECTRIC VEHICLE PENETRATION ON URBAN POWER DISTRIBUTION NETWORK

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DECLARATION

I declare that this is my own work and this dissertation does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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DEDICATION

To my loving mother
Deelin Wanigasuriya,
who made all of this possible,
for her endless
encouragement and patience.

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ABSTRACT

Electrified vehicles are a recent developing trend in transportation. It is a good solution for the reduction of fossil fuel usage on the transportation and hence the reduced CO_2 emission. Plug-in Electric Vehicles (PEVs) are driven by the electricity stored in its battery and therefore zero tailpipe emission. Thus, PEVs attract much interests of public due to its environmental friendliness and they will possibly emerge widely in city areas in the short-term future mainly for short distance travels. Most of the countries provide incentives (tax credits, grants) to purchase plug-in electric vehicles as promotion of green vehicle. During last two years usage of PEVs was increased in Sri Lanka. PEVs are becoming more popular due to the reduction of importing tax and the developing infrastructure in Sri Lanka. However, in worldwide, increasing number of PEVs will become a substantial load to the existing power grid which can be characterized as an unusual type of load. Therefore, it is essential to pre-investigate the inevitable impacts on the power system. Lot of studies has been carried out worldwide to investigate the both positive and negative impacts on power grid. But in Sri Lankan context, a proper study had not been carried out to examine the challenges we have to face due to the increasing penetration of PEVs. Thus this research study is aimed to evaluate the level of impact due to the residential and fast charging of increasing number of PEVs. Anticipated impacts on power system such as voltage drop, voltage unbalance, transformer overloading, line losses and current harmonic effect are addressed in this study. Charging behavior of PEVs is unpredictable due to the variation of travel needs and the driving patterns. This study basically evaluates the impacts on distribution network due to this uncoordinated charging of increasing number of PEVs. It also addresses the mitigation methods and the maximum number of PEVs can be charged during off-peak hours from the distribution feeder modeled.

Key words: Plug-in Electric Vehicles, Voltage drop, Voltage unbalance, Transformer overloading, current harmonics

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LIST OF ABBREVIATIONS

Abbreviation	Description
AC	Alternative Current
BEV	Battery Electric Vehicle
CEB	Ceylon Electricity Board
CEM	Clean Energy Ministerial
CO_2	Carbon Dioxide
DC	Direct Current
EV	Electric Vehicle
EVI	Electric Vehicles Initiative
EVSE	Electric Vehicle Supply Equipment
FFT	Fast Fourier Transform
HEV	Hybrid Electric Vehicle
ICE	Internal Combustion Engine
ICEV	Internal Combustion Engine Vehicle
IEA	International Energy Agency
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
LECO	Lanka Electricity Company
LV	Low Voltage
MV	Medium Voltage
NEMA	National Electrical Manufacturers' Association
PCC	Point of Common Coupling
PEV	Plug-in Electric Vehicle
PHEV	Plug-in Hybrid Electric Vehicle
PV	Photovoltaic
SCR	Silicon-Controlled Rectifier
TDD	Total Demand Distortion
THD	Total Harmonic Distortion
UK	United Kingdom
USA	United States of America
USD	United States Dollar
V2G	Vehicle to Grid

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