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A Comprehensive Review on Optimal Coordination of Electrical Vehicles to Reduce Power loss

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Abstract: This Paper aims to present a report on the study of the various methods of coordinating electrical vehicles in an optimal way so as to reduce the generation cost and the transmission power loss from Grid to load and Also to improve the charging performance of electric vehicles (EV) by various methods like Photo-voltaic(PV) roof mounted panels battery swapping and charging stations (BScSs), Branch Flow model based relaxed optimal power flow (BFM-RoPF), A physical fair Queueing framework, use of switched shunt capacitors(SSCS) etc. By comparing various methods of Coordination of electrical vehicles we can get a better solution to reduce the power loss and to improve the charging performance of electrical vehicles.
Index Terms: Optimal coordination of EVs, Roof mounted PV panels (BScSc), (BFM ROPF), Fair Queueing framework,(SSCs)

I. INTRODUCTION

Electric Vehicles (EVs) first came into existence in the mid-19th century, when electricity was among the preferred methods for motor vehicle propulsion, providing a level of comfort and ease of operation that could not be achieved by the gasoline cars of the time. EV could play a significant role in reaching the targeted goals of reducing dependence on conventional sources of energy, EVs can cause significant impacts on the environment, power system, and other related sectors. The present power system could face huge instabilities and challenges with enough EV penetration, but with proper management and coordination, EVs can be turned into a major contributor to the successful implementation of the smart grid concept that we so much envisaged. The penetration of EVs in the market has multiple concerns of fulfilment of their charging needs in various traveling scenarios. Many factors are responsible for the postponing of the sudden increase in number of EVs on the road, for instance, the limited range of EVs , long charging durations, less frequent availability of charging facilities, high initial investment cost etc. If the penetration of EVs in the near future is suddenly increased, it would pose some issues related to the load flows and power quality in the power distribution networks.

Charging requirements for EVs vary with the nature of the EV trips, for instance, short trips would require less energy from the EV's battery and hence it would not lead the EV battery to discharge at a critical level. This small portion of consumed energy from the EV battery could be recharged while it is parked at shopping malls, offices, or at all possible parking locations and at home over the night. As for short trips only a small percentage of the stored energy in the battery is consumed so it is feasible to even postpone the charging to some other time and charge it at low charging power.

However, in case of long trips more battery energy is being consumed so the quick charging of EVs is needed to complete the trip in a reasonable period of time. The fast charging of EVs demands high power to be drawn from the network for relatively shorter periods of time which gives rise to network capacity issues because of the simultaneous fast charging events. Many research articles have focused on the rescheduling of EV charging at home for the cost-effective charging solution for EVs for daily charging.

EVs can be considered as a combination of different subsystems that are coordinated to achieve self-sufficient operation. Each of these systems interact with each other to make the EV work, and there are multiple technologies that can be employed to operate the subsystems.

By some estimates electric vehicles sales may constitute almost a third of new car sales by the end of 2030.

When the electrical vehicles penetration increases it will become a problem for charging on time, or burden on the grid so to avoid that problems we should have a charging strategy and various coordination methods like Photo-voltaic(PV) roof mounted panels battery swapping and charging stations (BScSs), Branch Flow model based relaxed optimal power flow (BFM-RoPF), A physical fair Queuing framework, use of switched shunt capacitors(SSCS) etc.

II. GENERATION COST AND POWER CONSUMPTION ESTIMATIONS

In the recent studies the electricity costs for charging is, the fuel efficiency of an EV may be measured in Kilowatt hours (KWH) Per 100 miles. To calculate the Cost per mile of an EV the cost of electricity and the efficiency of the vehicle (how much electricity is used to travel 100 miles) must be known. If electricity costs 7.83 Rs per Kwh and Vehicle Consumes 34kwh to travel 100 miles, the cost per mile is about 2.85Rs. If electricity Costs 7.83 per kwh, charging an EV with a 70 mile range (assuming a fully depleted 24kwh battery) will cost about 2.64Rs to reach a full charge. This cost is about the same as operating an average control air conditioner for about 6 hours.

Charge consumption at home and at charging stations of an electric scooter, electric car and electrical vehicle are as follows 70 % of electrical vehicle users are charging at homes. Power consumption of electric vehicles at home on an average battery packs using electric scooters is 2kwh for 1unit in India is 2.5 Rs and for 2 units it is 5 Rs full charging For Electric cars battery packs in India for 25kwh is 62.5 Rs. Power consumption rates vary from 40-65 rs For electric 3 wheeler average battery packs is 4.5kwh, power consumption average price is 11.25 Rs. price varies from 8-12 Rs electricity prices may vary in different states in India. We consider average tariff rates.

So to reduce the charging cost we go for different charging methods From the below table we can say that according to our requirement we choose the charging time,power supply etc.

Table1: Discription of BEV

In the next section we are going to see various methods for coordination of electrical vehicles.

Charging time for 100 km of BEV range	Power supply	Power	Voltage	Max current
6-8 hours	single Phase	3.3 KW	230 V AC	16A
3-4 hours	Single Phase	7.4KW	230 V AC	32A
2-3 hours	three phase	11KW	400V AC	16A
1-2 hours	Three Phase	22KW	400V AC	63A
20-30 minutes	Three Phase	43KW	400 V AC	63A
20-30 minutes	Direct current	50 KW	400-500 V DC	100-125A
10 miutes	Direct Current	120 KW	300-500V DC	300-350 A

III. METHODS FOR COORDINATION OF ELECTRICAL VEHICLES

By comparing various methods of Coordination of electrical vehicles we can get a better solution to reduce the power loss and to improve the charging performance of electrical vehicles.

Generally, EVs consume much larger power than home appliances like air conditioners and heaters. For an individual user, charging an EV at home can be easily achieved by installing an outlet with high power rating.

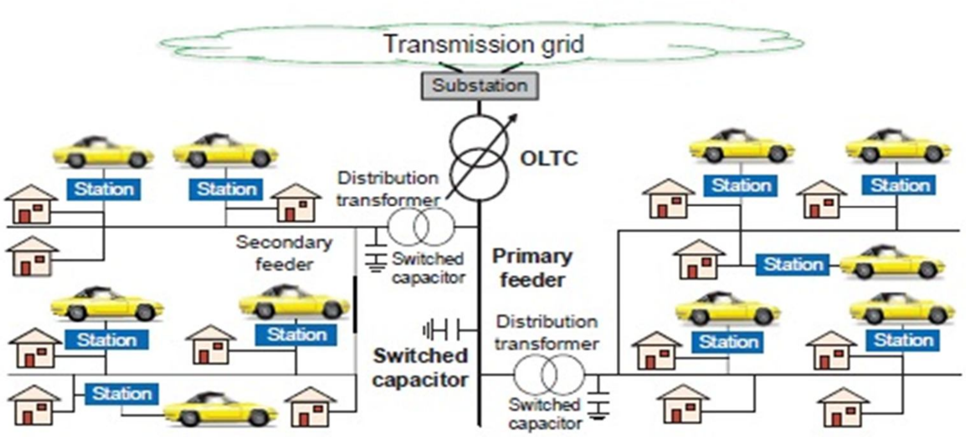

Fig1: A Distribution Grid with EV's.

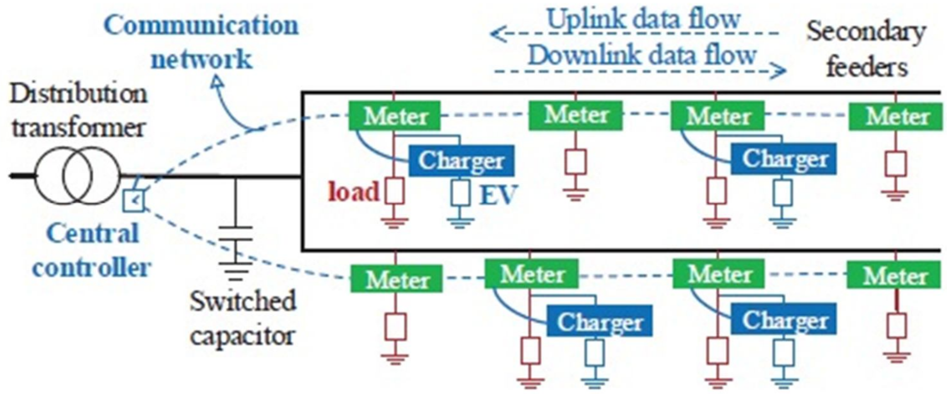

Fig2: The major components in a sub grid.

However, from the perspective of an entire distribution grid, if a large number of EVs are to be charged simultaneously, the peak load is expected to increase abruptly. Since the capacity of existing transformers is planned without considering the additional peak load from such EVs, these transformers can easily experience an overloading problem. EV charging also increases the current flowing through transmission feeders, which results in severe voltage drop along these feeders, especially in rural areas with long transmission feeders. Voltage below the operation range leads to an under-voltage problem, which can damage home appliances. As Per [1]to solve these problems, a physical fair-queuing framework is established for EV charging.

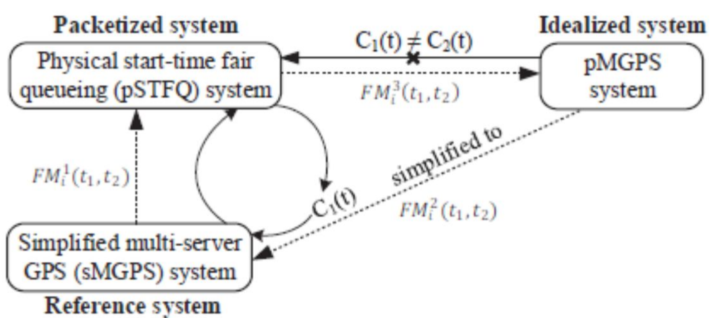

Fig 3: Overview of the solution to approximate pMGPS

In this framework, a distribution sub-grid is first mapped to a multi-server queuing system, and then a fluid-model based queuing scheme called physical multi-server generalized processor sharing (pMGPS) is designed. pMGPS ensures perfect fairness but cannot be used practically due to its nature of fluid model. To this end, a packetized scheme called physical start-time fair queuing (pSTFQ) is developed to schedule tasks of EV charging. The fairness performance of the pSTFQ scheduling scheme is characterized by the ratio of energy difference between pSTFQ and pMGPS. This critical performance metric is studied through theoretical analysis. The pSTFQ scheduling scheme achieves an energy difference ratio of less than 4 percent in various scenarios without causing under-voltage and transformer overloading problems.

Electrification of transportation has been considered as a promising solution to mitigate the carbon emission from transportation sector by integrating renewable energy and improve the reliability of the power system by utilizing the energy buffering property of electric vehicles (EVs)

As per [2] EV refuelling systems generally face two crucial challenges: i) as service providers, they need to guarantee a certain quality-of-service1 (QoS) for EV customers to maintain their business profits; ii) as large electricity consumers, they have to manage their energy consumption profile wisely to reduce their operational cost from the electricity bills and to help maintain the power system reliability. To understand and balance such mutual impact between QoS and operational cost, analytical models that can capture key features of the EV refuelling systems are desired.

As mentioned in [2]Battery Swapping instead of recharging EVs from electric socket, batteries could be mechanically replaced at special stations in a couple of minutes (battery swapping).Batteries with greatest energy density such as metal-air fuel cells usually cannot be recharged in purely electric way. Instead, some kind of metallurgical process is needed, such as aluminium smelting and similar. Silicon-air, aluminium-air and other metal-air fuel cells look promising candidates for swap batteries. Any source of energy, renewable or non-renewable, could be used to remake used metal-air fuel cells with relatively high efficiency. Investment in infrastructure will be needed. The cost of such batteries could be an issue, although they could be made with replaceable anodes and electrolyte.

IV. SURVEY ON ELECTRICAL VEHICLES COORDINATION STATERGIES

Xudong Wang have proposed a Scheduling of Electric Vehicle Charging via Multi-Server Fair Queuing [1].IN this paper he developed a physical fair queuing framework to solve under-voltage and transformer overloading problems. This framework consists of two fair queuing schemes: physical multi-server GPS (pMGPS) and physical start-time fair queuing (pSTFQ). pMGPS captures the characteristics of EV charging in a sub-grid, but cannot be directly applied, so pSTFQ was then designed as a practical packetized scheme to schedule EV charging. The performance gap between these fair queuing schemes was studied through theoretical analysis and was also evaluated via simulations. The energy difference ratio between pSTFQ and the idealized pMGPS is less than 4 percent in different scenarios, which illustrated that fair sharing of energy among EVs was achieved.

Bo Sun has proposed Optimal Charging Operation of Battery Swapping and Charging Stations with QoS Guarantee [2]. He has formulated the QoS guaranteed Optimal charging operation problem for BSCSs as a CMDP based on a novel queuing network model and tackled the computational difficulty of solving the CMDP. The accuracy and complexity of the proposed algorithm have been compared with the standard RVI methods and its superior performance has been validated by extensive numerical evaluations. Results have shown that the number of chargers in the BSCS has a larger impact in reducing the average charging cost when the system is operated under QoS-guaranteed optimal policies.

M. F. Shaaban has proposed Optimal Coordination for Electric Vehicles in Smart Grids with High Penetration of PV generation [3]. In this paper he proposed a day-ahead energy management approach to optimally schedule the operation of the flexible loads in addition to the installed battery storage systems. he formulated a systematic approach with an objective to minimize the day ahead operating cost while the requirements imposed by the power flow, voltage, thermal capacity, shift able and adjustable loads, and charging/discharging of battery storage are treated as constraints for optimization. This scheme has been tested on a typical 33-bus distribution system with DG installed at two buses and battery storage systems installed at 30percent of the homes. The results show that the controlled operation of shift able and adjustable loads in addition to battery storage systems can significantly reduce the cost of energy.

Hongjun Gao has proposed Robust Coordinated Optimization of Active and Reactive Power in Active Distribution Systems [4] in this he proposed a robust coordinated dispatch optimization model which simultaneously considers the uncertainties of wind power output and load demand for scheduling the on-load tap changer ratios, reactive power compensators, and charge-discharge power of energy storage system (ESS). He has performed a Case studies to demonstrate the effectiveness of the proposed method and achieved all the results and in future he is planning to do research by this method on real world power systems.

Sara Deilami proposed Online Coordination of Plugged-In Electric Vehicles and Optimal Rescheduling of Switched Shunt Capacitors in Smart Grid Considering Battery Charger Harmonics [5] in this paper she used A practical approach for online PEV coordination incorporated with offline SSCs rescheduling that reduces generation cost and charges all EV batteries while designating limits for transformer loading, voltage regulation and harmonics distortions. Algorithm can successfully charge all EV batteries at low and medium PEV penetration levels. It will keep the THDv level within the standard limit of 5% while controlling the voltage variations and minimizing the cost of generation. for High PEV penetrations The iterative procedure is used it stops when the THDv level is within the standard limit of 5% and the SSCs scheduling are almost constant. The simulation results show that the algorithm stops after 7 iterations.

Hence the proposed strategy can successfully resolve the harmonic distortions issues and manage the PEV charging schedules based on the PEV owners' desire.

V. CONCLUSION AND FUTURE SCOPE

Optimal Co Ordination of Electrical Vehicles is essential to reduce the generation cost, transmission power loss from Grid to load and to improve the charging performance of electrical vehicles and these all are achieved by various methods of optimal coordination of electrical vehicles. We presented an overview of these considerations.

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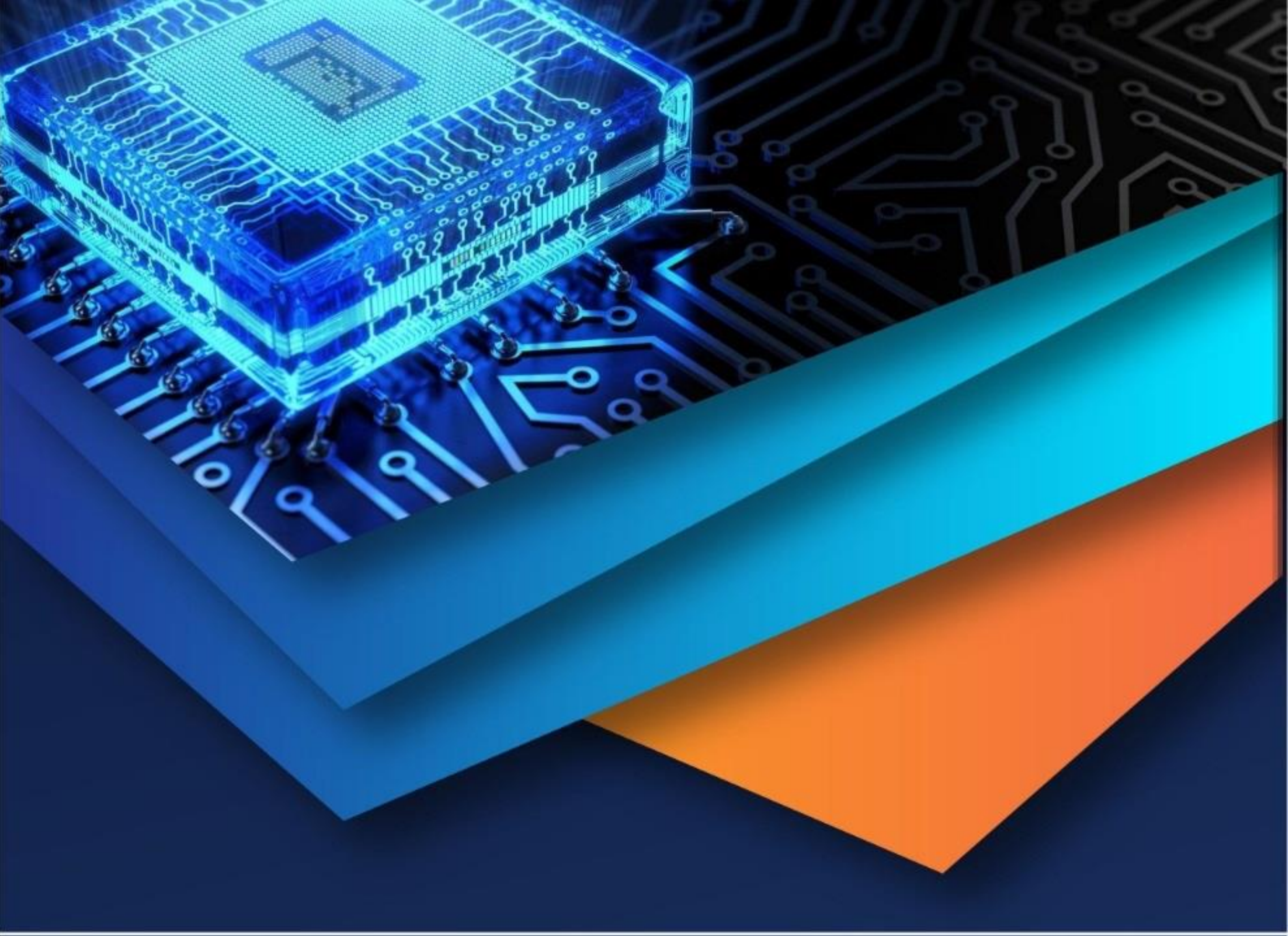

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