Electric vehicles: Network Modelling and Future Research Needs

Swapnil Namekar, Nikhil Sundram[2]
[1]*Assistant Professor, Department of Electrical Engineering, Bharati Vidyapeeth Deemed University, College of Engineering, Pune, India*
[2]*Student, Department of Electrical Engineering, Bharati Vidyapeeth Deemed University, College of Engineering, Pune, India*

***Abstract*- The objective of this review paper is to review the concept of electric vehicles and their network modelling approaches and future research needs .Electric vehicles are an effective solution for reducing of greenhouse gas emissions and pollutions present in our surroundings. As we all know demand of electric vehicles is much more but still electric vehicles are evolving and limited. This review paper first deals with the concept of electric vehicles, market share their characteristics and charging facilities. Then after study about traffic assignment problems and problems related to charging of electric vehicles. Moreover these vehicles are noiseless, pollution free and less maintenance.[1]**

***Index terms*- Electric vehicles, Network modelling, Traffic assignment problem, Vehicle routing problem, charging facility location problem.**

INTRODUCTION

Carbon emissions and greenhouse gases are one of the most critical issue according to the policy makers since 1998. At present transportation is 98% dependent on fossil fuel which is affected by changes in energy resources. Government and automobile companies have recognized the value of alternative fuel vehicles for green transportation and implement economic policies for support of electric vehicles market and overcome from issues related to electric vehicles.

Plug –in hybrid vehicle (PHEV) is one of the type of AFVs which reduces the emission of greenhouse effect. The hybrid gasoline –EVs is beneficial in future because it reduces the gasoline emission and green house emission from 30% to 50% without changing of vehicle class. Limited battery capacity is one of the major issue due to which it allows ranges between 150 and 200km. The widespread use of plug – in electric vehicles (PEVs) calls for fundamental changes of the existing network flow modelling tools as well as for evaluation of transportation development plans.

In this paper we explore different topics with respect to network modelling of

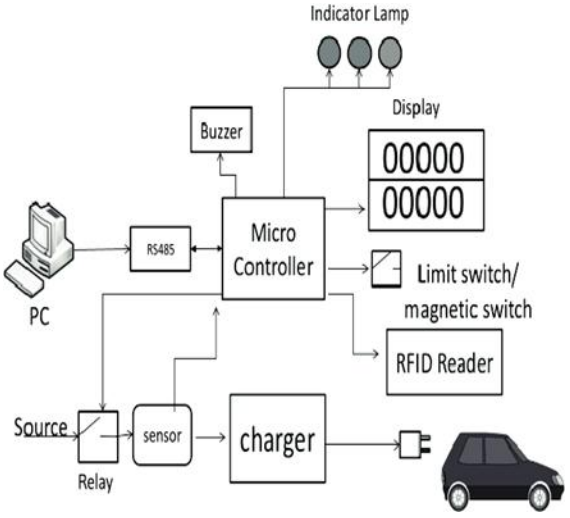
EVs. The respective topics are described as follows:

- In this section we discuss about the topic‘ Charging station design and location studies’ in which we studies about battery charging station and battery swapping station (BSS) location as well as their design.
- In section ‘PEV market potential, demand and behavior study’, the PEV market potential and it’s demand are reviewed from aspects of EVs, challenges and opportunities.
- In section ‘TAP of a vehicles with range limit’, studies about traffic assignment problems for electric vehicles network
- In section ‘Network design and bi-level model’, in this section we study about problems related to network designing of EVs.[2]

CHARGING STATION DESIGN AND LOCATION STUDIES

Charging is one of the major issue in case of electric vehicles so, charging facilities must be available for electric vehicle drivers. Government and EVs companies must have to seriously concerned about where to locate charging station and which type of charging station to locate because of the high cost.[9]the main power conversion system comprises of an AC to DC converter. The converter must have certain properties in order to safe, secure as well as

efficient charging. Although many of the cities are planning the construction and expansion of BEVs charging infrastructure. Batteries in electric vehicles are not the same as typical internal combustion engine vehicle battery. Electric vehicles battery powered everything in your vehicle, most importantly the electric motor. When a battery in an electric motor runs out of charge, you simply recharge it through grid electricity, phone etc. Charging can be done at home through wall outlet or at a designated charging station in a public parking area. Almost all electric vehicles use lithium ion battery because these are low maintenance, light weight and more efficient than others. [3]



PEV MARKET POTENTIAL, DEMAND AND BEHAVIOUR STUDY

The near future of the car is hybrid gasoline-EV , and it will likely become dominant vehicle platform by the year 2020. Global positioning system (GPS) illustrates that PEVs can match different household needs. Currently Smart and Schey analysed the Nissan Leaf, which is a BEV, and concluded that the drivers drove 6.9 miles per trip, 30.3 miles per day on average and the average number of charging times was 1.05 per day, as well as 82% of charging events were conducted at home. Chargers are categorized into different levels such as voltage levels and power levels. In level 1 there will be 120 V AC(Alternating current) up to 20 A (2.4 KW) ; In level 2 there will be 240 V alternating current up to 80 A (19.2 KW) and in level 3 there will be 240V alternating current and greater at power levels of 50-200 KW. [4]

TAP OF VEHICLES WITH RANGE LIMIT

It is the last step of the traditional four- step travel demand modelling process and widely used an evaluation tool for a variety analysis of urban and regional traffic network. The standard TAP can be solved efficiently using a Frank–Wolfe type algorithm within which the linearized sub-problem is to find shortest paths between each O–D pair. The problem of finding the shortest path for an EV was initially discussed by Ichimorietal. Where a vehicle has a limited battery and is allowed to stop and recharge at certain locations. [11]

NETWORK DESIGN AND BI-LEVEL MODEL

The network design and bi – level model of electric vehicles deals with the modification of a transportation system , By adding new link we just try to reduce the total system costs consisting of system travel costs and investment costs. The technique used to maintain equilibrium NDP is bi-level programming technique. NDP also applied in several electric vehicles for network designing. Bi-level models has been also applied for design the toll for transport network. [7]

Table 1. Overview of EV network modelling literature in the past 5 years.

Research topic	Studies
EV SPP	42,45,49–51,5
Optimum design of EV charging station	10,11,23,52
EV user behaviour and charging behaviour	31,34
EV charging station location problem	27,28,36,52,63
EV routing problem	44,47,52
Network equilibrium of EV	7,40

EV: electric vehicle; SPP: shortest path problem.

MULTI-CLASS USERS AND CORRESPONDING MULTI-CLASS CHARGING STATIONS

Some earlier research has been done on multiple class different electric vehicles. There are various types of electric vehicles having different battery capacities and different ranges.

CHAdeMO is the one of the most commonly used method of dc fast charging. Now, Tesla is rapidly increases and expanded their network which is based on their own connector and currently only tesla vehicles can charge by this

MICROSCOPIC EV BEHAVIOURS AND IMPACT OF EVS' SIGNAL PRIORITY

Signal priority is one of the effective way to reduce delay of electric vehicles by transmitting of signals from one place to another. Many cities in the world have just taken step to increase and promote electric vehicles market share, including government subsidy, free parking and signal priority. So, the special microscopic EV behaviours also remain to be a potential worthy direction in the future.

POTENTIAL IMPACTS WHEN ATTRIBUTES ARE RELATED TO EV CHANGE

Recent advanced technology suggest that driving range must be extended, charging time must be reduced and also reduce the cost of batteries. After sometime when there will be massive production of electric vehicles then the cost fall down. So, it is important to understand the market for electric vehicles in the future when there are large push and sizable investment of resources in favour of electric vehicles.

CONCLUSION

The paper presented represents an idea of bringing the electric vehicles on a large scale in urban areas as well as rural areas. We also discuss about charging systems and which batteries are more efficient for electric vehicles, bringing of signal priority in electric vehicles, how to extend ranges of electric vehicles, how to reduce the cost of electric vehicles. This paper shows that electric vehicles can easily solve the daily problems of public and private transport as well as electric vehicles are also an solution for freduction of pollution.

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