Plug In Hybrid Electric Vehicle- Indian Transport Sector Perspective

Vaibhav Aaradhi, Ketaki Gaidhani

Abstract— The major problem facing the Indian transportation and power sector is the increasing prices of the fossil fuels. The increasing fuel prices have a direct impact upon the Indian economy. As fossil fuels prices climbs higher, the search for alternative modes of transportation is needed. Pluggable hybrids are proving to be a complete new way to store and consume mass amounts of energy from the Indian power grid. This paper focuses on the importance of use of pluggable hybrids in India and infrastructure requirements for the same. This paper shall also discuss the challenges for implementation of pluggable hybrids in India. The paper shall help to provide an insight upon an effective launch in the Indian subcontinent.

Index Terms— PHEV's (Plug In Hybrid Electric Vehicle), Fossil fuels, Green fuel, Economic impact

1 Introduction

India's efforts to develop an efficient Smart grid does posses the following few pre-requisites theses include the power system should fully meet user's demand for electricity, optimize the allocation of power resources, ensure the security, reliability and economy of electricity supply, meet environmental constraints, and meet the electricity market development. Smart Grid should accept the variety of clean energy generation, optimize the structure power capacity, promote diversification of the power supply structure, and improve the proportion of low-carbon energy in energy structure, while improve the consistency and reliability of the grid. As the uncertainty and intermittent characteristics of the distributed renewable energy power generation, Smart Grid cannot develop without the support of energy storage. Distributed energy storage units of PHEVs can serve as a complement of the power grid to relieve tension of the power supply and improve network reliability. With development of technology, PHEV's can further reduce investment and operating costs of power system. Statistics show that passenger vehicles are, on average, parked and idle for about 23 hours every day. During this time, the battery in the passenger vehicles can act as distributed mobile storage unit of power system. And the battery power can feed back to the grid when the power supply is insufficient in grid. With the development of electric vehicles, V2G and its functions in smart grid attracts more and more attention.

2 Plug In Hybrid Electric Vehicles

Plug-in electric vehicles are growing in popularity due to increasing governmental regulations on industries and public opinion to reduce greenhouse gas emissions and move toward more sustainable technologies. Therefore, many automotive companies have already started to expand their production to capitalize on the growing electric vehicle market [3]. Following fig shows block diagram of Plug In Hybrid Electric vehicle.

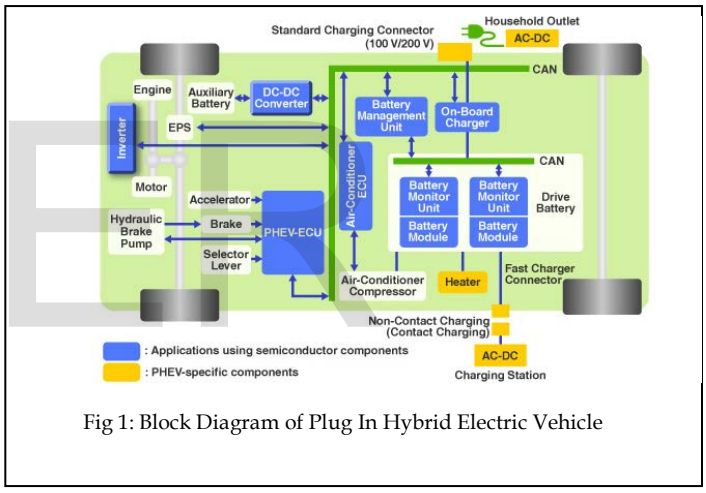

Fig 1: Block Diagram of Plug In Hybrid Electric Vehicle

PEVs offer numerous advantages over conventional fuel based vehicles such as; more efficient motors, low emissions, less reliance on fossil fuels, energy storage for grid surplus and vehicle-to-grid (V2G) capability for supporting grid during peak times. PEVs can come in many variants such as all-Battery Electric Vehicles (BEVs) and Plug- In/Hybrid Electric Vehicles (HEVs/PHEVs) which combine battery powered electric motor propulsion (for short intercity driving) with conventional fuel based internal combustion engines (for long range cruising). The latter hybrid PEV type is currently the most popular. PEVs are anticipated to be charged in public or corporate car parks, electric charging stations, or at a customer's premises. Therefore, in order to support PEVs in the near future, an electric vehicle network complete with charging stations and infrastructure to support residential PEV charging is necessary. This will be an important function of newly developing smart grids proposed to modernize century old distribution system design for future energy requirements [3].

- *Vaibhav Aaradhi is currently pursuing masters degree program in electric power systems at KKWIEER , University of Pune, India, He has a work experience in GIS with Crompton Greaves Ltd,Nashik,India as a Development -R&D Engineer. Email: vaibhav_aaradhi2006@yahoo.co.in*
- *Ketaki Gaidhani is currently pursuing masters degree program in electric power systems at KKWIEER , University of Pune, India, Shee has a work experience in Design and development of APFC panels with TDK-EPC*

Typical PEV battery capacities presently range from a few kWhs to over 50 kWh. In order to charge these batteries in a time period similar to filling the tank of a fuel based car, it is expected that most PEVs will have multiple charging modes allowing slow to rapid charging. Lithium-ion titanate batteries are showing promise with their lightweight, energy dense and rapid recharge capability [3].With a suitable battery charger, it may be possible to recharge these batteries in approximately 10 minutes with 95% of full charge. For example, the newly released Mitsubishi iMiev PEV offers home charging from 15A 240 V (Australia) power supply. The battery charger itself is built into the PEV. The iMiev offers the quick charge facility using a special socket supplied from a rapid charge unit such as those to be installed in charging [3].

The PHEVs can be further split up into the following categories:

- On-Road Highway Speed Vehicles An On-Road Highway Speed Vehicle is an EV capable of driving on all public roads and highways. Performance of these On-Road vehicles is similar to Internal Combustion Engine vehicles.
- City Electric Vehicles Traditionally, City Vehicles have been BEVs that are capable of driving on most public roads, but generally are not driven on highways. Top speed is typically limited to 55 mph.
- Neighborhood Electric Vehicles (NEVs) Neighborhood electric vehicles (NEVs), also known as Low Speed Vehicles (LSVs) are BEVs that are limited to 25 mph and are allowed in certain jurisdictions to operate on public streets posted at 35 mph or less.
- Commercial On-Road Highway Speed Vehicles There are a number of commercial electric vehicles, including commercial trucks and buses. These vehicles are found as both BEVs and PHEVs.

3 INDIAN TRANSPORT SECTOR SCENARIO

Roads are the most important mode of transportation in India today. They carry almost 90 percent of the country's passenger traffic and 65 percent of its freight. The density of India's highway network -- at 0.66 km of highway per square kilometer of land [1].

The urban population in India has grown from ten percent in 1901 to forty percent in 2013. Nearly seventy percent of the urban population is located in Metropolitan cities .This heavy concentration of population in a few centers has resulted in the expansion of cities in density as well as area. With the increase in population and economic activities the travel demand has increased many folds. The inadequate public transport and the easy availability of financing facilities for private vehicles have resulted in increased vehicle ownership levels and their usage. Further, the changes in urban form and structure in terms of lad use, density of population and concentration of activities have changed the travel pattern[5].

The following Pi chart representation shows the yearly category-wise growth in vehicle sales in India

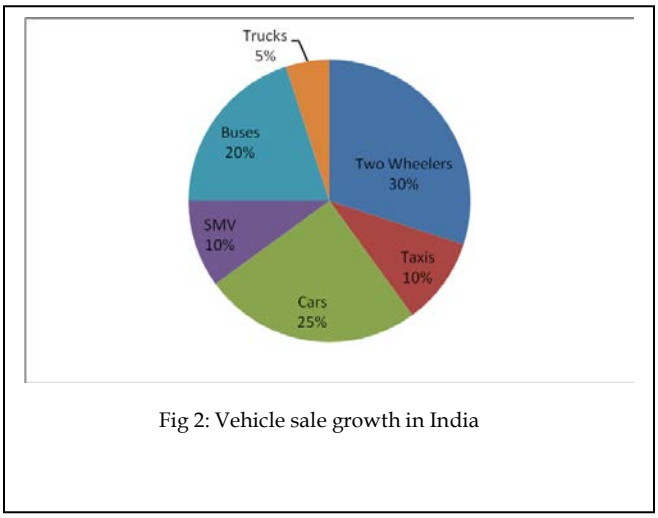

Fig 2: Vehicle sale growth in India

From the above representation it may be seen that the Indian transport sector does have an extremely high potential when it comes to an implementation of Hybrid electric vehicle and its smart grid application in India.

4 FOSSIL FUEL CONSUMPTION PATTERN IN THE INDIAN VEHICLES

The Indian transport sector showed a tremendous growth considering the vehicular traffic in the past 10 years. The fuel consumption also has gone up exponentially considering this growth. The oil consumption went up from 2130000 (bbl/day) in 2001 to 33000 (bbl/day) in 2012

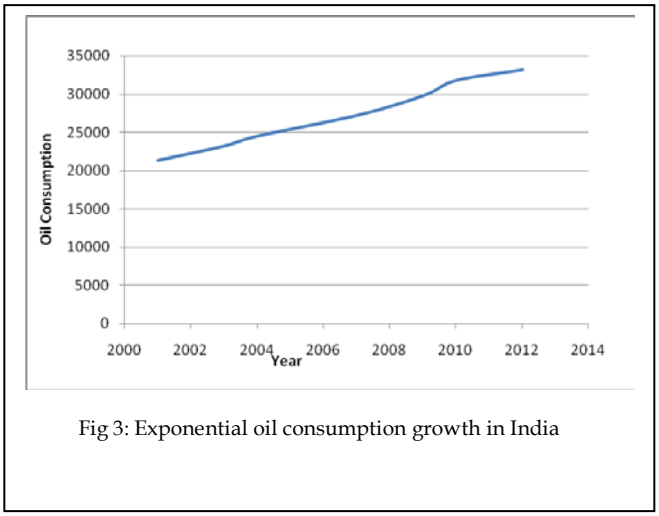

Fig 3: Exponential oil consumption growth in India

The oil consumption increase pattern which is accompanied by the price rise of the fuels has lead to the planners to search out for various alternate means to reduce the fuel consumption and the promotion to the use of Hybrid electric vehicles in the Indian subcontinent. However the implementation of this technology does come with many challenges to be faced by the power sector and transport sector in India.

5 CHALLENGES FOR PHEV IMPLEMENTATION IN INDIA

- The PHEV technology since its inception sets a major drawback of increased cost as a result of which it finds lower acceptance in the majority of middle class income group of Indian population
- The increase in charging station requirement is bound to be extremely high which comes with its own drawbacks.
- The battery charging times for all vehicles are appx. 1 hour, thus this leads to a lower acceptance as compared to the conventional fuelled vehicles.
- The increase in demand-generation gap which is already quite high in the Indian power sector is bound to worsen if there is an increase in the use of PHEVs.
- Considering the Indian population the amount of load of power system will be extremely high during the peak load periods.

6 INFRASTURCTURE REQUIREMENT FOR PHEV IMPLEMENTATION

- Overnight charging facilty in household garages
- Overnight charging facility in apartment complexes.
- Opportunity charging at commercial facilities
- Dedicated charging stations setup similar to fuel stations
- Charging facility at industries and IT parks.

The Infrastructure requirement for PHEV implementation though involves a large amount of capital investment this is quite balanced out by long term benefits to the power system.

7 CONCLUSION

Due to increasing prices of fossil fuels need for alternative source of energy for transportation arises. The PHEVs do hold a good scope for development in the Indian subcontinent considering its benefits and are due to get implemented in India considering the challenges mentioned in this paper.

8 REFERENCES

[1] Electric Vehicle technology explained, James Larminie, John Lowry, John Wiley & sons ltd
[2] Electric vehicle battery systems, Sandeep Dhameja, Newnas, Boston Oxford Johannesburg Melbourne New Delhi.K. Pohlink, E Mikes, P. Ponchon, "New aspects of reliability in gas insulated substations", IEEE paper no.1-4244-0493-2/06.
[3] Murat Yilmaz Philip T. Krein ,"Review of Charging Power Levels and Infrastructure for Plug-In Electric and Hybrid Vehicles and Commentary on Unidirectional Charging", 2012 IEEE International Electrical Vehicle Conference (IEVC'12) .IEC 62271-203 International standard.
[4] Electric Vehicle Charging Infrastructure Deployment Guidelines for the Oregon I-5 Metro Areas of Portland, Salem, Corvallis and Eugene.Shigemitsu Okabe,Tokio Yamagiwa IEC 62271-203 .
[5] F. Musavi, M. Edington, W. Eberle, and W. G. Dunford, "Evaluation and Efficiency Comparison of Front End AC-DC Plug-in Hybrid Charger Topologies," IEEE Trans. Smart Grid, vol. 3, no. 1, pp. 413-421, March 2012..
[6] State of the Art Report on Battery Chargers for Plug-in Hybrids 2010, ABB AB/Corporate Research April 2010.