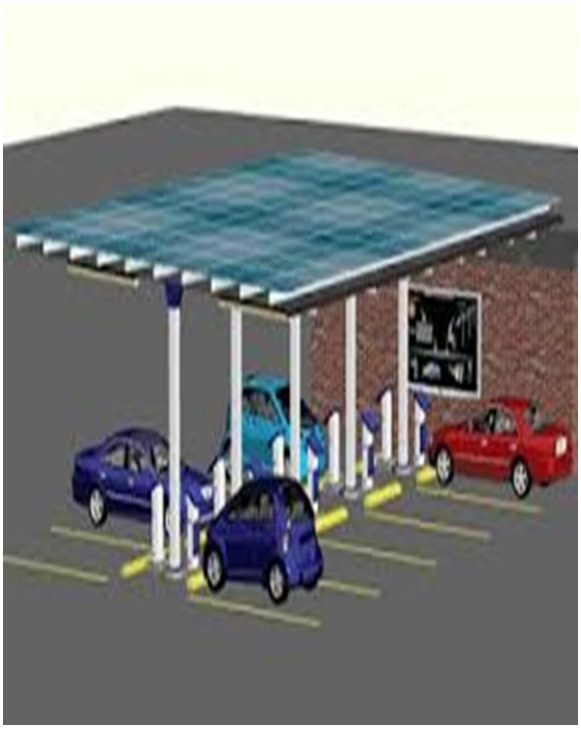

ELECTRIC VEHICLES IN INDIA AND ITS IMPACT ON GRID

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Abstract:

The document briefly covers the challenges of EV proliferation, its impact on grid and glimpses of Singapore, Amsterdam policy for EV

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Electric Vehicles in India and its impact on Grid

Background

Road EVs include a large range of vehicles from electric two-wheelers, three-wheelers (rickshaws), cars and electric buses. In addition, plug-in electric vehicles can be classified into two types: battery electric vehicles (BEVs), and plug-in hybrid electric vehicles (PHEVs). BEVs have an electric motor in place of combustion engine and use electricity from the grid stored in batteries. Plug-in hybrid electric vehicles (PHEV) use batteries to power an electric motor and liquid fuel such as gasoline or diesel to power an internal combustion engine or other propulsion source.

EVs can go beyond the above mentioned technology based classification, and can be classified on the basis of their attributes such as i) charging time, ii) driving range, and iii) the maximum load it can carry. Of these attributes, the two most important characteristics of an electric vehicle of concern to the consumer are:-

1. Driving range (i.e. the maximum distance an EV can run when fully charged)
2. Charging time of batteries (i.e. the time required to fully charge the battery) and
   Charging time depends on the input power characteristics (i.e. input voltage and current), battery type, and battery capacity.

Battery in EV

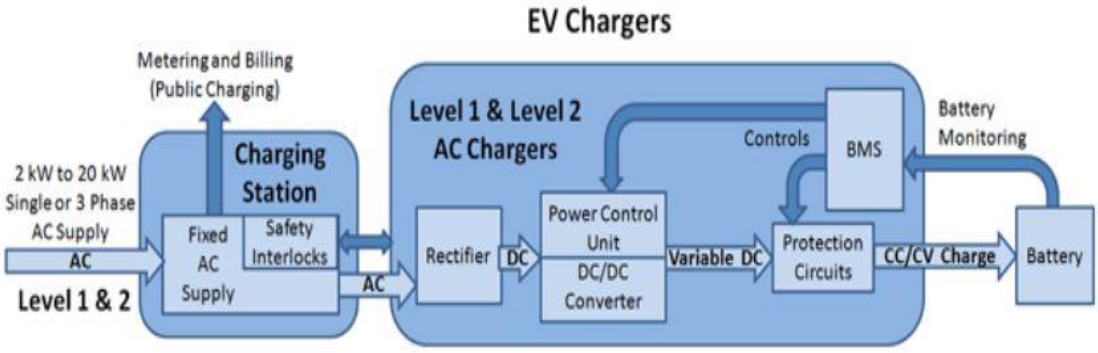
The choice of batteries depends on the energy density, weight and costs. Electric cycles and low range mopeds have simple battery units while electric cars deploy a large number of batteries.

Traditionally, most electric vehicles have used lead-acid batteries due to their mature technology, easy availability, and low cost. However, since the 1990s battery technologies have evolved significantly and several new types of batteries have been developed. More recently, batteries using combinations of lithium ion and its variations are gaining widespread acceptance due to better efficiency, reduced weight, lower charging time, better power output, longer lifetime, and reduced environmental implications from battery disposal.

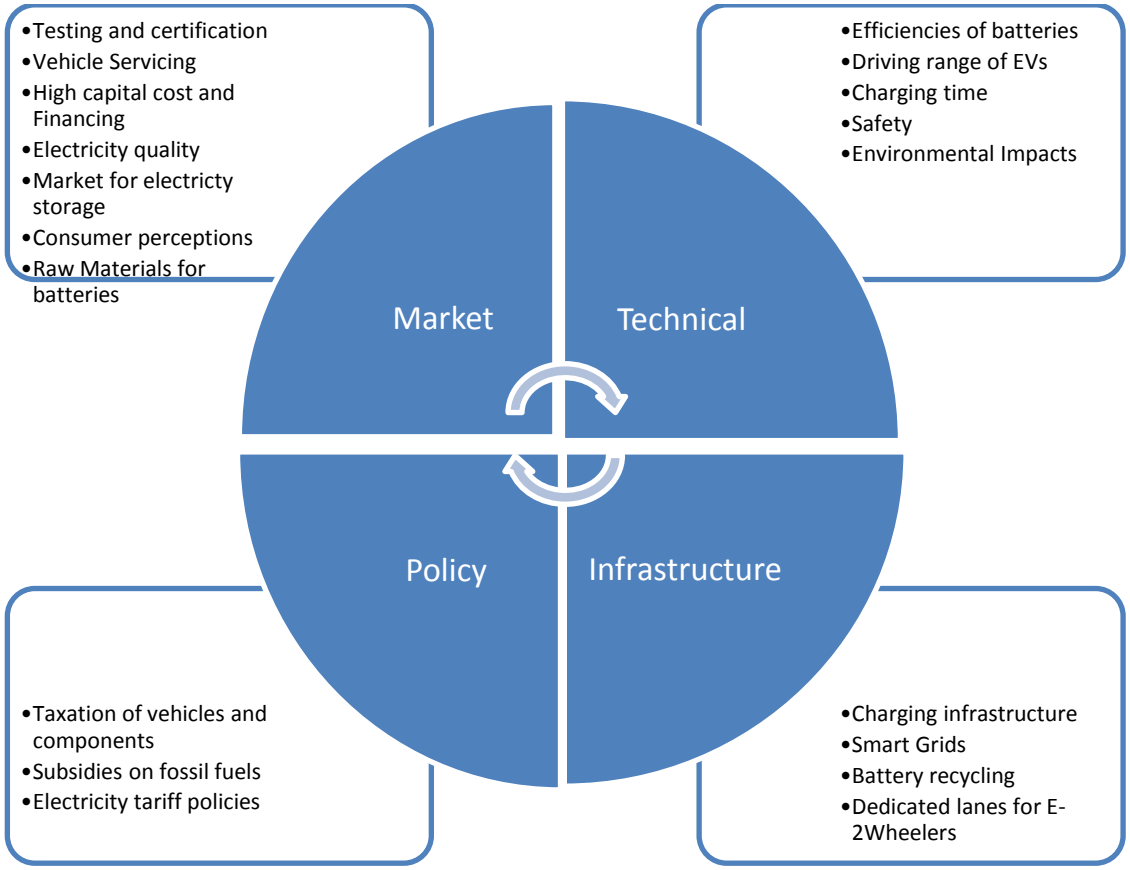
The following four types of batteries are commonly used today in EVs: 1) Lead Acid, 2) Nickel Cadmium (NiCd), 3) Nickel Metal Hydride (NiMH), and 4) Lithium-ion (Li-ion). Lithium-ion batteries have higher specific energy relative to the other battery types. In the future, technology innovations with Li-ion and other battery technologies are expected to result in batteries with much higher specific energy and lower costs.

Battery Charging

In low power applications the power conditioning which includes the AC to DC conversion, the power control unit which delivers a variable DC voltage to the battery, and various filtering functions are all carried out within the charger and can be implemented at a relatively low cost. The Battery Management System (BMS) is tightly integrated with the battery. It monitors the key battery operating parameters of voltage, current and temperature and controls the charging rate to provide the required constant current / constant voltage (CC/CV) charging profile and it triggers the protection circuits if the battery's operating limits are exceeded, isolating the battery if needed. Battery charging scheme is shown in the figure below.



Ecosystem for Electric Vehicles



Policy related challenges include choosing and instituting policy instruments to promote EVs, setting up infrastructure, incentivize automobile manufacturers to produce EVs, and induce consumers to switch to EVs. Should the infrastructure be ready before penetration of EVs could go up? Or should the penetration of EVs reach a 'tipping point' before the required infrastructure is rolled out? The dilemma confronts policymakers, automobile manufacturers and the related businesses.

The deployment and scaling up of EVs in urban areas greatly depends on the quality and access of charging infrastructure, and facilitation of a supply chain for charged batteries. Charging infrastructure includes low speed charging stations in homes and workplaces as well as fast charging points located in public areas including shopping malls, petrol pumps, public parking and mass transit stations. Globally, several city governments have introduced plans and policies to improve EV infrastructure.

Global Case Study

Singapore

Singapore will launch an electric vehicle (EV) car-sharing programme in collaboration with Bolloré Group by mid-2017. a nation-wide car-sharing programme with a fleet of 1,000 EVs. Bolloré Group is the world's largest EV car-sharing operator, with operations in Paris, Bordeaux and Lyon in France, Indianapolis in the US and Turin in Italy. Bolloré Group was selected out of 13 participants in a Request for Information (RFI) exercise in December 2014,

Under the agreement, BlueSG Pte Ltd will operate the programme for ten years and install an island-wide EV charging infrastructure of 2,000 charging points, of which up to 20 per cent will be available for public use. These charging points will form the foundation for Singapore's future EV charging infrastructure to support the use of EVs in Singapore. Compared to privately-owned EVs, EV shared-car fleets have the potential of reaping economies of scale with higher daily mileage and potentially lower running costs. Fleet-based trials involving e-taxis and e-buses will also be conducted.

Singapore will adopt the Type 2 AC and Combo 2 charging systems according to the IEC 61851 series and 62196 series, for new charging stations installed in publicly-accessible premises starting from 1 August 2016. All 2,000 charging points will comply with this standard. The Type 2 charging standard, which is a European charging interface, is compatible with both single-phase and three-phase power supplies, which allows for normal and semi-fast charging of EVs. For example, when connected to a charging station with three-phase power supply, an EV can be charged in as fast as one to two hours. This standard will therefore strengthen the charging eco-system for EVs.

Singapore's value proposition to businesses not just to help them improve their bottom line, but also to help them grow their top line through establishing and deepening strategic activities in Singapore to drive their business, innovation and talent objectives in Asia and globally.

Amsterdam

The case of Amsterdam is a good example illustrating how public charging infrastructure in combination with policy measures can play a positive role in stimulating electric mobility in a city context (van der Hoed, 2013). The city currently has over 400 charging stations. Consumers can get to know about the location and capacity of each charging station on website. This growth in number of charging stations and easy availability of information has encouraged the use of charging infrastructure in terms of number of sessions and charging time.

Highlights of Amsterdam EV scenario:-

- ✓ Amsterdam played a pioneering role in the development process for Dutch/European charging plugs. The defined standard applies to all Dutch and European car manufacturers.
- ✓ In 2011, Europe's first fully electric taxi company (Taxi Electric) was launched in Amsterdam.
- ✓ From October 2014, all journeys by taxi departing from Amsterdam Airport Schiphol are made in electric cars (the Tesla Model S).
- ✓ In December 2011, the City of Amsterdam introduced a new subsidy scheme to stimulate high-mileage corporate car users to switch to electric transport. This subsidy scheme helped 750 electric vehicles on the road (February 2015).
- ✓ Car2Go offers 350 electric cars in Amsterdam as part of their car sharing scheme. An international first is that all Car2Go vehicles in Amsterdam are 100% electric. Car2Go cars may use the charging stations across the city and are permitted to park at all parking spaces in the city without the driver incurring additional parking charges.
- ✓ The Amsterdam ArenA stadium car park is home to Europe's (and probably the world's) first smart charging hub. The 20 charging points communicate with each other to determine which car requires the most power.

INDIAN EV SCENARIO

National Electric Mobility Mission Plan (NEMMP) 2020

•Target of deploying 5 to 7 million electric vehicles in the country by 2020

•Emphasizes importance of government incentives and coordination between industry and academia

•Target of 400,000 passenger battery electric cars (BEVs) by 2020 ~ avoiding 120 million barrels of oil and 4 million tons of CO2

•Lowering of vehicular emissions by 1.3 percent by 2020

•Total investment required –INR 20,000 – 23,000 cr (approx 3 billion USD)

e-RIKSHAW:-

- ✓ The Government of India announced the Deen-Dayal scheme in June 2014, which would help in the financing and procurement of the battery rickshaws in the country
- ✓ In March 2015 the Motor Vehicles (Amendment) Bill was cleared establishing battery-powered e-rickshaws as a valid form of commercial transport
- ✓ 3 wheeled vehicles run by battery power of no more than 4,000 Watts
- ✓ 4 passengers, luggage of 50 kg and with a single trip under 25 kilometers

- ✓ The number of battery operated e-rickshaws in Delhi has risen from 4,000 in 2010 to more than 1,00,000 in 2014, and is now an integral part of the transport eco-system in the state.
- ✓ In January 2014, Tripura became the first state in India to regulate the functioning of the e-rickshaws, and they came up with the Tripura Battery Operated Rickshaw Rules 2014 for the purpose.
- ✓ Tripura Battery Operated Rickshaw Rules 2014 consists norms / guidelines such as driver age limits, license fee, renewal fee, Road Tax, provision for vehicle fitness certificate, insurance for e-rickshaw and identification of routes for operation of these vehicles.
- ✓ 22,000 licenses granted,

Drivers for growth of electric vehicles in India:-

Thirteen out of 20 cities in the world with highest air pollution are in India. It is envisaged that Low carbon scenario with 'highest' EV penetration shows 50 percent drop in PM 2.5 by 2035 (UNEP, DTU and IIM-A) .

Master plans for most cities in India target 60-80 per cent public transport ridership by 2025-2030 (Center for Science and Environment)

With the Government of India targeting 100 GW of solar by 2022, electric vehicles can improve reliability and utilization of renewable by acting as storage

However, there needs to be proper planning with reference to monitoring and control of charging infrastructure as unplanned increase in penetration of EVs in an area can lead to increase in peak load of already stressed distribution network.

Large scale penetration of EVs will require both demand side incentives (e.g., tax incentives) and improved charging infrastructures as well as integrated planning for distribution Grid management.

EVs offer the opportunity to act as a distributed storage in the urban energy system which could help in better integration of intermittent renewables like wind and solar and can feed the grid at peak timings if price incentives are designed in terms of dynamic tariff as part of Smart Grid implementation.(V2G)

Recommendations:-

1. **Adequate capacity addition primarily through Renewables in distribution grid in order to meet additional demand created by high penetration of EVs. (**Some areas in Delhi witnessed around 20% rise in peak demand in this summer, further study can be done to determine if the same is due to increase in e-rikshaws).
2. EV charging station to be designed preferably with rooftop solar generation to minimize dependence on fossil fuels in entire supply chain hence shifting towards clean energy.
3. Encourage EV manufacturers to design vehicles with changeable batteries, so that EV owner can just move in the charging station, replace his battery with fully charged battery and

move on. The charging station can plan to charge the batteries during off peak time at reduced electricity tariff or direct from roof top solar power.

4. Use of dynamic pricing model and smart grid tools for charging stations to encourage charging at non-peak timings hence aiding to Peak Load Management.
5. Area wise integrated planning of public transport, EV promotion and Renewable Generation with dynamic pricing of electricity and Smart Grid tools for monitoring and control.
6. Adoption of EV standards Charging connector standards are being developed by Automotive Research Association of India. Rating of charging sockets: Does household 16A sockets are good enough for household EV charging? Or does it need industry standard sockets?
7. Utility to sanction installation of charging point at homes for EV charging based on available capacity of distribution grid in that area.
8. Identification of EV charging nodes in the existing distribution network without affecting the voltage profile of the network.
9. Suitable pricing mechanism to be developed, in case Utility needs to augment the distribution grid to support EV charging.
10. Intelligent Charging Stations equipped with Fast chargers, timers and capable of switching to normal charging mode based on real time grid conditions/parameters.
11. Battery disposal/recycling norms as per (**Batteries (Management and Handling) Rules, 2001**) published by Ministry of Environment, Forest and Climate Change need to be strictly enforced so as to prevent adverse environmental impacts of battery.
12. Investment in R&D for future battery technologies resulting in batteries with much higher specific energy, environment friendly and lower costs. As batteries constitutes 50% cost of EV's.
13. Other initiatives that may help scale up EV in cities include local plans for electric vehicles, subsidies, dedicated parking and related incentives, use of information technology (IT) to locate charging stations, collaboration with private companies, as well as public car share and lease.

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