Recommendations for Electric Vehicle Policy and Charging Infrastructure for Incorporating in the NEMMP Framework and Policies

Submitted to:
National Automotive Board
Ministry of Heavy Industries, Government of India

BACKGROUND

To discuss various issues related to wide spread adoption of Electric Vehicles (EV) rollout, India Smart Grid Forum (ISGF) under the aegis of Smart Utilities Group (SUG) called various stakeholders for a one day workshop on “Effect of Electric Vehicle Penetration on Electric Grid” on 11th of April 2015.

This brainstorming session raised several important questions related to Electric Vehicle rollout in India and its effect on the Electric Grid. It was decided to form a subcommittee by SUG members to work on recommendations related to appropriate EV charging infrastructure and business models that are sustainable and submit to the National Automotive Board (NAB), Ministry of Heavy Industries for incorporating in the National Electricity Mobility Mission Plan 2020 (NEMMP) framework and policies.

About India Smart Grid Forum (ISGF)

The India Smart Grid Forum (ISGF) is a public-private partnership (PPP) initiative of the Ministry of Power, Government of India. The mandate of ISGF is to advise government on policies and programs for promotion of Smart Grid in India, work with national and international agencies on standards development; technology demonstration projects and to help utilities, regulators and the Industry in technology selection, and training and capacity building

About Smart Utilities Group (SUG)

ISGF launched the Smart Utilities Group (SUG) with the objective of providing an effective platform exclusively for utilities for knowledge dissemination and experience sharing and learn from each other on new technologies for grid modernization and effective customer services.
# TABLE OF CONTENTS

A. SCENARIO MAPPING OF ELECTRIC VEHICLE (EV) ROLL-OUTS AND GRID IMPLICATIONS ............................................. 3

B. RECOMMENDATIONS FOR CHARGING INFRASTRUCTURE, ELECTRICITY TARIFF DESIGN AND PAYMENT SETTLEMENT MECHANISMS ........................................................................... 4

  1. CHARGING INFRASTRUCTURE FOR EVs .............................................................................................................. 4
  2. ELECTRICITY TARIFF FOR EVs ............................................................................................................................. 5
  3. PAYMENT SETTLEMENT MECHANISMS .................................................................................................................. 6
  4. EV CHARGING STATION OWNERSHIP AND OPERATION ...................................................................................... 6
  5. BATTERIES FOR EVs ............................................................................................................................................... 7

C. APPLICABLE STANDARDS AND OTHER RECOMMENDATIONS .............................................................................. 8

D. INCENTIVES FOR ELECTRIC VEHICLES .................................................................................................................. 9

E. EMERGING TRENDS - ENABLE CHARGING STATIONS WITH INTEROPERABLE NETWORK INFRASTRUCTURE .9

F. ENABLE GRID-CONNECTED ELECTRIC VEHICLES AND ENERGY SYSTEMS ...................................................... 9
ISGF – SUG RECOMMENDATIONS

A. SCENARIO MAPPING OF ELECTRIC VEHICLE (EV) ROLL-OUTS AND GRID IMPLICATIONS

1. As a part of National Electric Mobility Mission Plan 2020 (NEMMP), Ministry of Heavy Industries (MoHI) has formulated a scheme called “Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India” (FAME-India). The overall scheme is scheduled to be implemented by 2020, wherein it is intended to support the xEV market development and its manufacturing eco-system to achieve self-sustainability at the stipulated period.

2. FAME-India envisage to cover following types of vehicles:
   a. Two wheelers (Category L1 and L2 as per Central Motor Vehicles Rules, 1989 (CMVR))
   b. Two wheelers (with maximum power not exceeding 250 W)
   c. Three wheelers (category L5 as per CMVR)
   d. Passenger vehicles (Category M1 as per CMVR)
   e. LCVs (Category N1 as per CMVR)
   f. Buses (Category M3 as per CMVR)
   g. Hybrid Retrofitment (Category M1, M2 & N1 of CMVR)

The above is further detailed in the table below:

<table>
<thead>
<tr>
<th>Category of Vehicle</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>2 W (Motorcycle) and Three Wheelers</td>
</tr>
<tr>
<td>L1</td>
<td>Maximum design speed not exceeding 45 km/hour and engine capacity not exceeding 50 cc, if fitted with a thermic engine</td>
</tr>
<tr>
<td>L2</td>
<td>Maximum design speed exceeding 45 km/hour and engine capacity exceeding 50 cc, if fitted with a thermic engine</td>
</tr>
<tr>
<td>L5 (Type A) – 3 Wheelers</td>
<td>L5 category vehicle whose maximum design speed is not more than 50 km/h and maximum net power does not exceed 4 kW in the case of internal combustion engines or maximum 30 minutes power in the case of an electric motor</td>
</tr>
<tr>
<td>L5 (Type B) – 3 Wheelers</td>
<td>For vehicle that is not Type A</td>
</tr>
<tr>
<td>M</td>
<td>Motor vehicle with at least four wheels used for the carriage of passengers and their luggage</td>
</tr>
<tr>
<td>M1 (Cars)</td>
<td>Motor vehicle used for the carriage of passengers and their luggage and comprising no more than eight seats in addition to the driver’s seat</td>
</tr>
<tr>
<td>M2 (Mini Buses)</td>
<td>Motor vehicle used for the carriage of passengers and their luggage and comprising more than eight seats in addition to the driver’s seat and having a maximum mass not exceeding 5 tonnes</td>
</tr>
<tr>
<td>M3 (Buses)</td>
<td>Motor vehicle used for the carriage of passengers and their luggage and comprising more than eight seats in addition to the driver’s seat and having a maximum mass exceeding 5 tonnes</td>
</tr>
<tr>
<td>N (Trucks and LCVs)</td>
<td>Motor vehicle with at least four wheels used for the carriage of goods</td>
</tr>
<tr>
<td>N1</td>
<td>Motor vehicle used for the carriage of goods and having a maximum mass not exceeding 3.5 tonnes</td>
</tr>
<tr>
<td>N2</td>
<td>Motor vehicle used for the carriage of goods and having a maximum mass exceeding 3.5 tonnes but not exceeding 12 tonnes</td>
</tr>
</tbody>
</table>
3. As the roll out scenario is dependent on customer behaviour, it is difficult to forecast how many EVs will be charged where and when which is a challenge for electricity distribution companies (Discoms) to plan infrastructure requirements to support EVs.

4. Cost Benefit Analysis need to be carried out by Discoms for installing a systems to limit simultaneous charging of many vehicles from the same node vis-a-vis increasing the capacity of distribution transformers at potential EV concentration centres (malls, parking lots, metro/railway stations, airports, high end gated communities, commercial centres, hotels etc). By leveraging suitable technologies, communication and control strategies Discoms can defer the investment in distribution system upgrade and additional generation capacity on account of EVs.

**B. RECOMMENDATIONS FOR CHARGING INFRASTRUCTURE, ELECTRICITY TARIFF DESIGN AND PAYMENT SETTLEMENT MECHANISMS**

1. **CHARGING INFRASTRUCTURE FOR EVs**

   The standards which are being drafted by committee formed by MHI have following specifications:

   a. AC charging - 16A for normal charging; and Type 2 (xx A) for fast charging
   b. DC charging - slow charging (100V system); and fast charging (70A/140A/250A voltage up to 500V+)

   Following are the recommendations for charging infrastructure:

   1. EV charging infrastructure for urban areas, highways and rural India could be of following types:

<table>
<thead>
<tr>
<th>Location</th>
<th>Type of Chargers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential Colonies</td>
<td>Normal Chargers</td>
</tr>
<tr>
<td>Railway stations, metro stations, bus stations etc</td>
<td>Normal Chargers and Fast Chargers for Buses</td>
</tr>
<tr>
<td>Malls, market places</td>
<td>Normal and Fast Chargers</td>
</tr>
<tr>
<td>Commercial centres, hospitals, hotels etc</td>
<td>Normal and Fast Chargers</td>
</tr>
<tr>
<td>Campuses, industrial parks</td>
<td>Normal Chargers</td>
</tr>
<tr>
<td>Petrol pumps</td>
<td>Fast Chargers</td>
</tr>
<tr>
<td>Highways</td>
<td>Normal and Fast Chargers</td>
</tr>
<tr>
<td>Bus Stations/Key Bus Stops</td>
<td>DC Fast Chargers</td>
</tr>
</tbody>
</table>

   (Need to discuss with NAB and agree on the range of Normal, Fast and DC Fast Chargers)

   2. Communication for information exchange, and safety and cyber-security aspects shall be considered while designing charging infrastructure and enabling their networks.

   3. One of the issues that may arise for chargers at different places (e.g., residence, railway stations, commercial centres, campuses etc) is that it may lead to unlawful drawal of electricity due to the tariff differential. Such aspects will have to be considered when designating appropriate locations for EV charging points and tariffs.
DISCOMS may approach respective Regulatory commissions for creating specific tariff category for EV charging stations).

4. Present regulatory framework doesn’t permit resale of electricity. A business model and regulatory approval by which a way side restaurants/parking lot operators can install and maintain charging stations and parking bays in good fettle needs to be worked out.

5. A sustainable EV Charging infrastructure model could be created through a Battery Pump Model with collaborative participation of the Oil Marketing Cos (OMC), Battery Cos and Discoms operating in a particular region; or other sustainable business models

6. Solar PV modules may be integrated with charging infrastructure where ever feasible

7. EVs can be leveraged as energy storage devices for behind the meter applications by EV owners as well as virtual power plants by Discoms for grid support. This will require necessary regulation and policies for EVs to pump energy into grid.

8. Model standard operating practices (SOP) for charging infrastructure may be developed

2. ELECTRICITY TARIFF FOR EVs

1. Separate tariff category may be created for electric vehicle charging through public infrastructure which may be dynamic and concessional based on grid situation. Necessary Regulatory approval may be obtained for separate EV tariffs. Discoms to take up this matter with respective SERCs and State Governments

2. For home users, there could be two categories (which are commonly used in the United States):
   i. **Home and EV on Time of Use (ToU):** EV charging costs are incorporated into customer’s total household electric bill. Only single meter is used for billing purpose.
   ii. **Only EV on Time of Use (ToU):** Customer can opt to have in-home charging station on a separate meter which will keep EV charging costs distinct from the rest of the home. Unlike our other residential rate plans, the EV rate plans will not be tiered. There will be two separate meters one for home and other for EV charging station.

3. Considering that there are a larger number of Two Wheelers and Three Wheelers in India it is recommended that:
   i. Two Wheelers may be allowed to charge from NORMAL PLUG POINTS at residential tariffs at home and other commercial/industrial establishments at tariffs applicable to those establishments – NO SEPARATE TARIFF FOR ELECTRIC TWO WHEELERS
   ii. Three Wheelers may be able to charge only at public charging stations (SPECIAL PLUG POINTS) which can have a separate tariff – some cases the city governments can even subsidize electricity cost for charging E-Rickshaws to promote clean public transport and reduce pollution within the city
   iii. Four Wheelers may be able to charge only from EV Charging Stations (SPECIAL PLUG POINTS) at home, offices and other public charging stations for which special tariffs may be designed by respective Discoms and SERCs considering the local priorities of each state/city/town
iv. Electric Buses and other large public/goods transportation vehicles may be allowed to charge only from public charging stations (SPECIAL PLUG POINTS). Again the electricity tariff for charging of electric buses and other goods transportation vehicles could have special tariff as considered appropriate by the local authorities, Discoms and State Electricity Regulatory Commissions (SERCs). Fast chargers may be provisioned for Buses.

4. Use of differential pricing for different times of day and night may be promoted. Differential pricing for locations that may see concentration at some time during the day and rest of the day very lean load. Example: EV chargers at or around cinema halls or malls where people would be away for 3 hours, might see shortage of spots and past cinema/mall hours those spots would be little or unused. To control the number of vehicles one could use differential pricing in these places. Differential pricing for EV charging could also help renewable energy integration – subsidised rates when surplus generation from RE resources on the grid.

3. PAYMENT SETTLEMENT MECHANISMS

Possible payment settlement options which could be offered to EV users are:

1. Prepaid cards issued by Discoms/third parties
2. Credit/Debit cards
3. Cell phone credits
4. Cash option
5. Mobile wallets
6. Reward points etc.

Different Business Models will require different payment settlement options. For example, E-Rickshaw fleet might prefer cash settlement and high end residential customer may opt for credit/debit card and loyalty/reward points for charging in shopping malls.

Vehicle to Grid technologies may be considered and an EV owner may be charged with or incentivised on net consumption (import-export) basis.

4. EV CHARGING STATION OWNERSHIP AND OPERATION

Multiple ownership options may be allowed, including 3rd party deployment of charging infrastructure. Different business models have been tried in different countries with various combinations of a Battery Leasing and Battery Swap model executed through Charging Infrastructure solely owned by a Battery Supply Company and operated by the Battery Supply Company, Land provided by Oil Marketing Companies (OMC)/any other local land owner. Here the role of the Discom may be limited to provide electricity to Charging Infrastructure.

NOTE: Looking abroad, California and Washington state have just moved to allow Discoms to include any of these investments in their rate base. Italy, Ireland and the Netherlands also allow DSOs to make these investments and pass the costs on to end customers.
Some of the options are shown in table below:

<table>
<thead>
<tr>
<th>Models</th>
<th>Role of DISCOM</th>
<th>Responsibility for Investment</th>
<th>Land Ownership</th>
<th>Proposed Tariff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1 (Power Supplier Model)</td>
<td>Supply power to operator</td>
<td>NA</td>
<td>100% Capital investment+ Maintenance</td>
<td>Land owning agency. Lease/rent paid by Operator</td>
</tr>
<tr>
<td>Model 2 (Franchisee Model)</td>
<td>Installs charging station on sharing basis &amp; supplies power</td>
<td>70% capital investment</td>
<td>30% capital investment</td>
<td>Franchisee</td>
</tr>
<tr>
<td>Model 3 (Lease Model)</td>
<td>Installs charging station on lease basis &amp; supplies power</td>
<td>5 years lease based charging stations</td>
<td>NA</td>
<td>Land owning agency</td>
</tr>
</tbody>
</table>

A model in which minimum investment from the Discoms (as they are already capital starved) but support development of a sustainable entrepreneurial ecosystem should be promoted as a national policy.

5. BATTERIES FOR EVs

1. Although the cost of Lithium–Ion Batteries (LiBs) are very high, most of the EV manufacturers are opting for LiBs. Lithium ion batteries for EVs have come down significantly in cost over the last 5 years, falling from around $1,000/kWh in 2010 to below $500/kWh in 2015, and are expected to fall further as volumes scale up.

2. It is recommended that LiBs may be made mandatory for 4 wheelers. Advanced lead acid could also be allowed for Two Wheelers and Three Wheelers up to year 2020; and after that LiBs (or other efficient & environment friendly batteries) may be made mandatory for all categories of EVs.

3. For all types of batteries efforts may be made to make manufacturing and recycling facilities available in the country as well as collection network established locally.
4. Policy framework may be put in place for promotion of second hand market for used EVs batteries for PV/street lightning applications which can bring down the entry cost for LiBs and faster transition from lead acid batteries.

A detailed study regarding cost vs battery sizing (power/energy) may be undertaken.

C. APPLICABLE STANDARDS AND OTHER RECOMMENDATIONS

1. The most important of the challenges among all these is the use of EVs and their support for the Discoms for the grid balancing. Managed or Smart Charging (one-way) and Vehicle to grid (V2G) features may be enabled in the EVs and the Charging infrastructure may be capable of delivering power back to the grid.

2. There are international standards available for information exchange between EV and power charging infrastructure and connectros (IEC 61851-1-2010 and 62196-3-2014) and for vehicle to charging station communications (ISO/IEC 15118 using HomePlug GreenPHY over Power Line Communications), which can be adopted in India. The recent work of IEC 61851/62196 focus on direct current (DC) fast charging.

3. While the two current (AC) charging levels, level 1 and level 2 are globally supported by the SAE 1772 standard, there is no consensus on a common standard for DC fast charging. The U.S. and European industry is leaning toward SAE 1772 combo coupler standard (CCS) for DC fast charging, which can also be adopted in India.

4. There are international standards for enabling communication and networking of charging station infrastructure such as Open Charge Point Protocol (OCPP), which can be adopted in India.

5. There are international standards for enabling grid connectivity for demand response and price communications such as Open Automated Demand Response (OpenADR), which can be adopted in India.

6. The charger should deliver a fixed DC output voltage with a limited Power Rating and may have following specifications
   a. Efficiency: Greater than 90%
   b. Current THD: Lesser than 5%
   c. PF: Greater then 0.9

7. The output power can be delivered through a contactor to an EV only after the vehicle has been positively identified through a communication protocol either directly using the in-vehicle telematics or through the connectivity through the charging station.

8. All EVs (except Two Wheelers) shall connect to the charger though a predefined connector that carries the power and the communication protocol connections.

9. The communication protocol shall help:
   a. Identify the type of the vehicle, the type of battery, the state of charge of the battery and enable the charger only if all predefined conditions are satisfactory
   b. Identification of the payment mode, enable payment collection and authorize the charging of the EV

10. The charger may be equipped with a card reader (credit/debit/prepaid) in order to enable consumer to pay for the charging facility.

11. The charger must have overload capabilities and may automatically disconnect in case of an overload or tamper.
12. Intelligent chargers may be placed which will limit the simultaneous charging of electric vehicles and will avoid overloading of transformers. Ideally charging stations should be integrated with the Building Management Systems (BMS) where ever feasible and in-turn the BMS should be integrated with the Distribution Management Systems (DMS) of the Discoms.

13. Leveraging EVs for Ancillary Services (AS) and Demand Response (DR) programs may be examined in detail and appropriate policies and incentives may be designed. Large number of EVs connected to the grid operating as virtual power plants (VPP) can support the grid in times of demand – supply imbalances. This could also help mitigate the rebound effects after a DR event.

14. Ideally a smart meter should be installed at the consumer level so that Utility can have the consumption data and it will help in implementation of demand response as well.

D. INCENTIVES FOR ELECTRIC VEHICLES

Following incentives may be offered for faster adoption of EVs. These types of incentive programs have been shown to significantly increase adoption rates in other countries:

1. Free parking slots for EVs with charging points wherever feasible
2. Extra incentives for PV based and storage integrated charging stations
3. Toll exemptions and designated lanes for EVs at toll booths
4. Allowing EVs to use BRT lanes (where ever applicable)
5. Concessional tariffs for EV charging during non-peak hours, holidays and seasons of low demand on the grid or times of surplus power on the grid
6. Tax concessions for EVs and Charging Stations

E. EMERGING TRENDS - ENABLE CHARGING STATIONS WITH INTEROPERABLE NETWORK INFRASTRUCTURE

An adequate infrastructure of charging stations, also called Electric Vehicle Supply Equipment (EVSE), is a key enabler for EV adoption and allows the owners to overcome the “range anxiety” barrier. When coupled with interoperable communication and networks, these EVSEs enable operators and EVs with cost-effective management services and ease their integration with utility or bulk system operator’s grid management systems. Access to data and interoperable network are essential for ubiquitous use of EVSEs by the EV owners. Such features are essential for utilities and owners to eliminate stranded assets, which can result from proprietary technologies. Using royalty-free open standards such as Open Charge Point Protocol (OCPP) for EVSE network management, an EV owner can use any charging station. Technology integrators can access data to provide innovative solutions such the availability of the nearest charging station, charging costs, track energy usage, etc.

F. ENABLE GRID-CONNECTED ELECTRIC VEHICLES AND ENERGY SYSTEMS

The lessons from enabling interoperable Smart Grid for demand-management services such as DR in buildings also apply to EV fleet. Network management of EVSEs using OCCP allows utilities and third-parties access to connected EVs and provides grid services using DR and pricing standards such as Open Automated Demand Response (OpenADR). This is an important requirement as peak electricity demand and electric reliability are key issues in India, which will be significantly multiplied by EV charging.
Consider an interoperable EVSE infrastructure with the following functionalities. Track their usage (to an EV and an EV owner):

1. Availability status (online, offline, and in use)
2. Charging power levels (calculate charge time needs of EV owners)
3. Location (find the nearest charging station)
4. Energy use metering (for usage statistics, demand response settlement)
5. Billing models (direct to EV owner, free public charging, via workplace charging)
6. Network/Communication connectivity (for Internet-based services)
7. Control features (for grid services and electricity cost management)
8. Remote firmware upgrades and troubleshooting (ease EVSE management)
9. Consider integration of EV and EVSE system with utility DR management systems to provide grid balancing and reliability services such as:
   a) DR programs
   b) Better integration of renewable generation
   c) Variable EV charging tariffs