A Case Study on Potential Impact of Electric Vehicle Charging for an Electricity Distribution Utility in India

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• Electric Vehicle (EV) market is at infancy in India
  • Only 0.06% car market shared by EVs (both battery electric vehicles (BEV) and plug-in hybrid electric vehicle (PHEV)) until 2017
  • Uptake of electric technology in 4-W) segment has been slow

• Charging infrastructure backbone of e-mobility – to boost EV adoption

• EV represents both opportunities as well as some serious challenges for DISCOMs
  • Additional electricity sales, increase in revenue
  • Impact on peak load, cost of power procurement

• Understanding the probable daily pattern of EV charging and its contribution to the peak and off-peak load is crucial.
  • Estimation of when, where, and how much EV will charge allows utilities to adjust their load projections to incorporate additional load from EVs
Few studies discussed below:

• **LBNL (2017)**
  - If GoI achieves 100% electrification target by 2030 – additional load from BEV charging is about 3.3% of the total electricity load in India (82 TWh/yr)
  - Contribution of BEV to peak-load – about 6% of the total peak load by 2030 (402 GW).

• **Forum of Regulators (2017)**
  - Impact of fast charging
    - 50% loaded commercial feeder can absorb up to 20% of additional EV load
    - Residential feeder can safely handle a ratio of 60%:40% from the residential load and EV load
  - Impact of slow charging negligible on feeders

• **Ali and Tongia (2018)**
  - EVs could add up to 50% to peak demand and 3% points to peak demand growth in 2017 to 2030
  - Total electricity demand for EVs may vary between 37 and 97 TWh under 33% and 100% penetration of EVs in sales by 2030
Electric Vehicle (EV) Charging: Pattern

• Electric Power Research Institute (EPRI) – Salt River Project in Arizona
  - Vehicle data logging devices were used to track 100 EVs
  - ~81% of charging occurred at home
  - Only ~3% of charging occurred at public charging locations

• Ola Mobility Institute (OMI) – Nagpur, India
  - Studied EV charging pattern of cab fleet owners/operators
  - Power demand at charging stations peaked during noon time (12pm-4pm) and at night (8 pm- 12 am)
  - 63.5% of charging happening in these two slots
Case Study: DISCOMs in Delhi

• **Four DISCOMs considered**
  - BSES Yamuna Power Limited (BYPL)
  - BSES Rajdhani Power Limited (BRPL)
  - Tata Power Delhi Distribution Limited (TPDDL)
  - North Delhi Municipal Corporation (NDMC)

• **Data and Methodology**
  - Year: 2018-19
  - Tariff Orders, FAME and MoP guidelines
  - Excel based model to study the EV charging pattern, impact on Energy Demand, Peak Power and contribution to ACoS

• **Assumption**
  - **Baseline**: 1100 EVs (1000 – 2W, 3W and 4W; 100 – electric bus)
  - Assumed that bus charging for intra-city transport happen at the depot during nighttime
  - Proportion of vehicles divided into public charging during day and home charging at night
  - Depth of discharge of the battery: 70%
  - Efficiency factor: 95%.
EV Charging Scenarios

Scenario I: If all vehicles are starting charging at the same time

Scenario II: If 50% of vehicles are starting charging at the same time

Scenario III: If 30% of vehicles are starting charging at the same time
Energy consumption increase from 24% to 31% between 12 AM to 6 AM. Most of the energy consumption from EV charging is happening at home.
Impact on Peak and Energy Demand for DISCOMs in Delhi
Impact on Average Cost of Supply (ACoS)

- Additional demand from EV charging results in both purchase of additional energy as well as increase in additional sales of energy for DISCOMs

- In case of NDMC, 0.24 million EVs cause 1% increase in ACoS resulting in additional power requirement of 451 MW and energy consumption by 1020 MWh
- In case of BRPL, BYPL and TPDDL, 1% increase in ACoS caused by 2.76 million, 1.42 million and 2.06 million respectively.

**Number of EVs causing 1% increase in ACoS and their impact on peak and energy demand**

<table>
<thead>
<tr>
<th>DISCOM</th>
<th>Number of EVs (in ‘000)</th>
<th>Additional Power Requirement for EV Charging (MW)</th>
<th>Increase in Energy Consumption from EVs (MWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NDMC</td>
<td>240</td>
<td>451</td>
<td>1020</td>
</tr>
<tr>
<td>BRPL</td>
<td>2,760</td>
<td>5021</td>
<td>11346</td>
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<tr>
<td>BYPL</td>
<td>1,420</td>
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<tr>
<td>TPDDL</td>
<td>2,060</td>
<td>3749</td>
<td>8473</td>
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</tbody>
</table>
Discussion

• Impact of EV adoption could alter the energy consumption pattern of Delhi and increase the energy demand at night from 24% to 31%

• Electric bus charging would be major contributor to additional load from EV charging at DISCOM level

• Peak demand from EV charging would happen at nighttime between 12 AM to 6 AM

• In case of public charging stations, 4W charging contributes the maximum to power demand under all charging scenarios

• Impact on cost of supply from EV is marginal at low levels of adoption

• EV penetration will have major impact on NDMC ACoS vis-à-vis other DISCOMs.

• Impact of EV adoption on increase in average cost of supply is not same across DISCOMs in the same state
Conclusion and Way forward

- Micro level studies are important to understand the impact from EV charging in a DISCOM area.
- Impact on power and energy demand on a DISCOM load curve is sensitive to number of vehicles and the pattern of EV charging.
- Among other EV category, energy needed for electric buses requires special attention, especially for DISCOMs that have peak power demand at night.
- Further, investigation is needed to account for seasonality in energy demand as load curves varies with season.
- Accounting contribution from renewable generation is important which can contribute towards daytime charging.
Thank You!!

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