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

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Context Setting

- 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

Electric Vehicle (EV) Charging – Peak and Energy Demand

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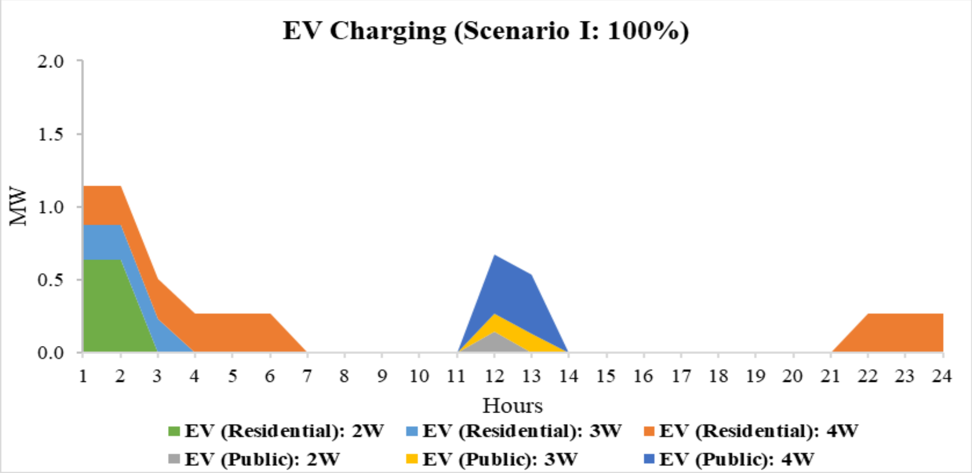
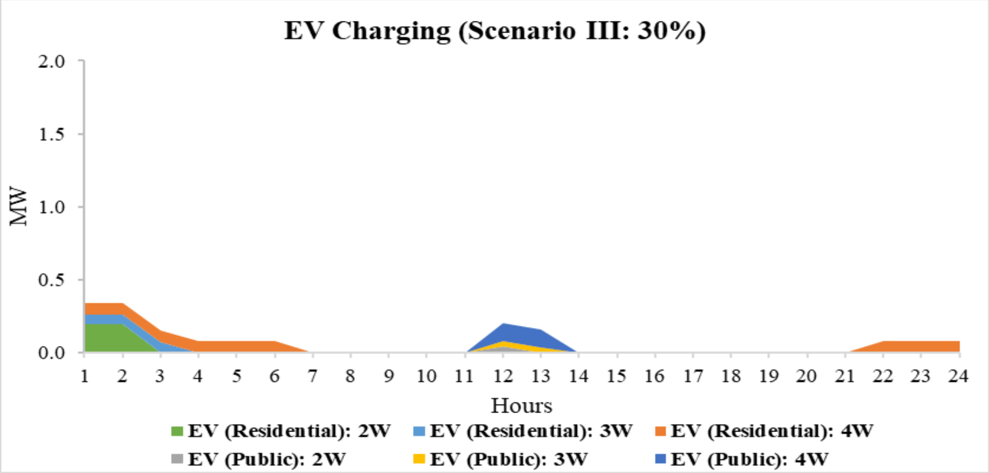
- **Assumption**
  - Baseline: 1100 EVs (1000 – 2W, 3W and 4W; 100 – electric bus)
  - Assumed that bus charging for intra-city transport happen at the depot during nighttime
  - Proportion of vehicles divided into public charging during day and home charging at night
  - Depth of discharge of the battery: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

EV Charging Scenarios

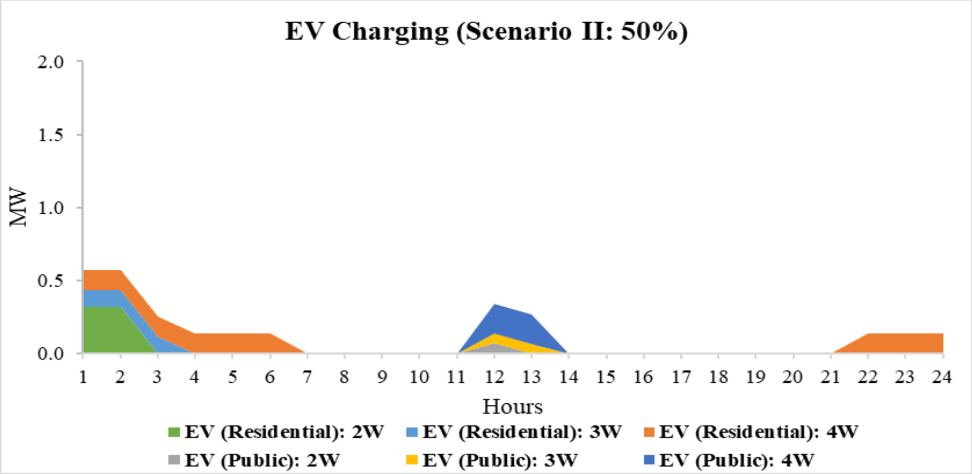
Scenario I: If all vehicles are starting charging at the same time



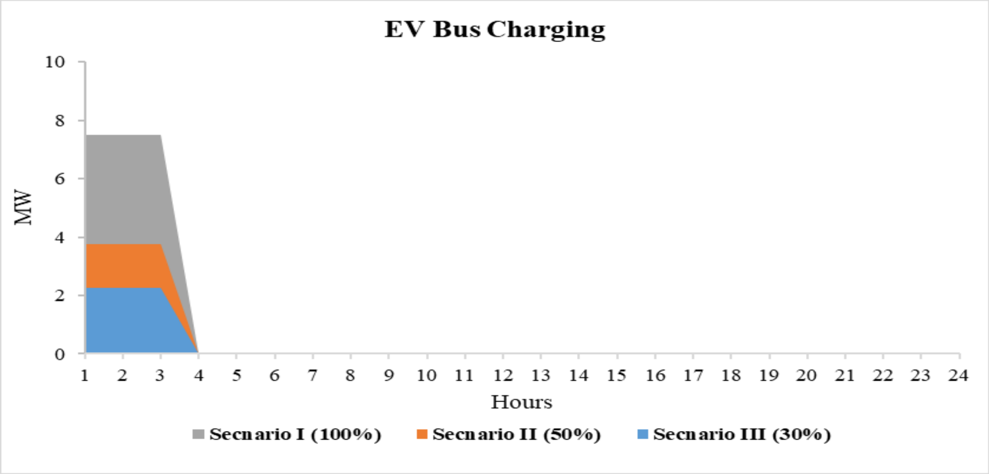
Scenario III: If 30% of vehicles are starting charging at the same time



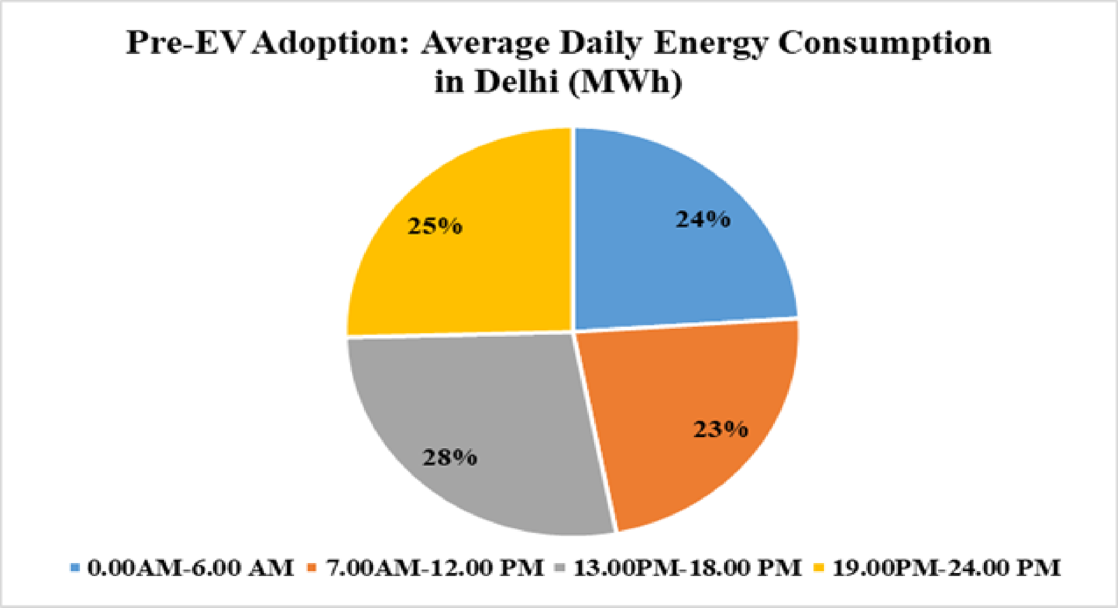
Scenario II: If 50% of vehicles are starting charging at the same time

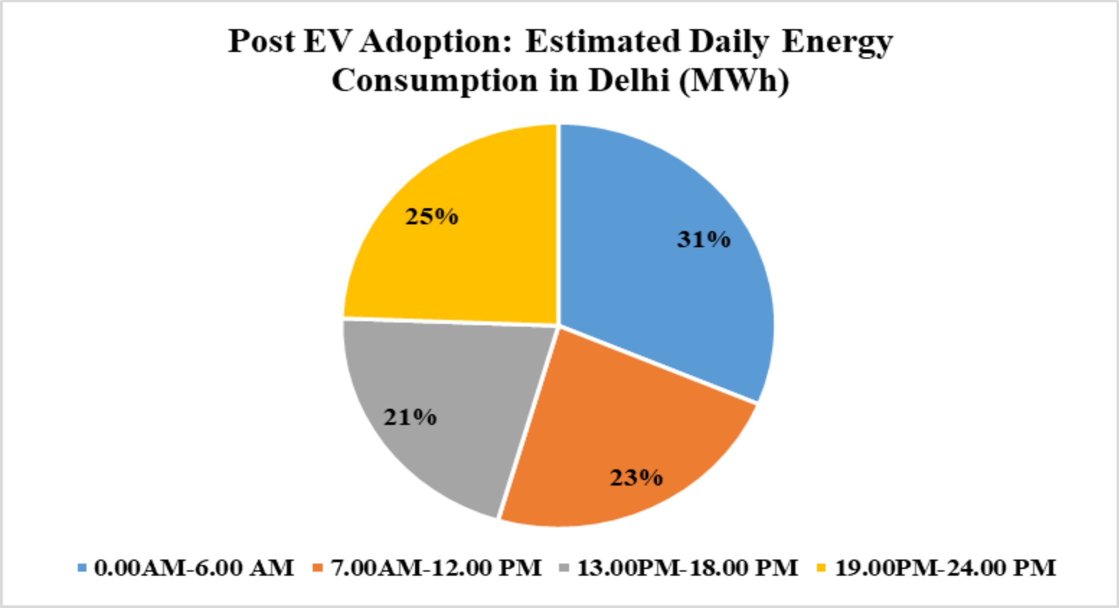


Electric Bus Charging showing three scenarios



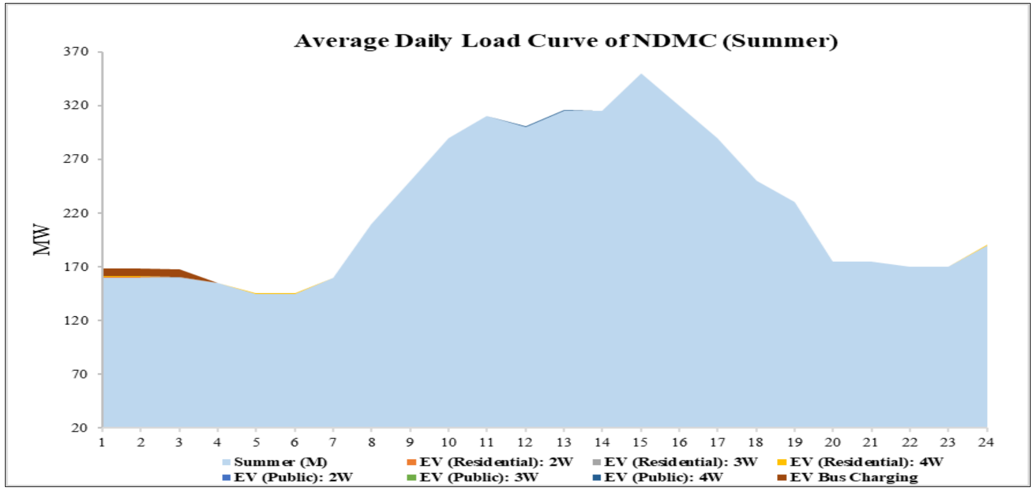
Impact on Energy Demand in Delhi

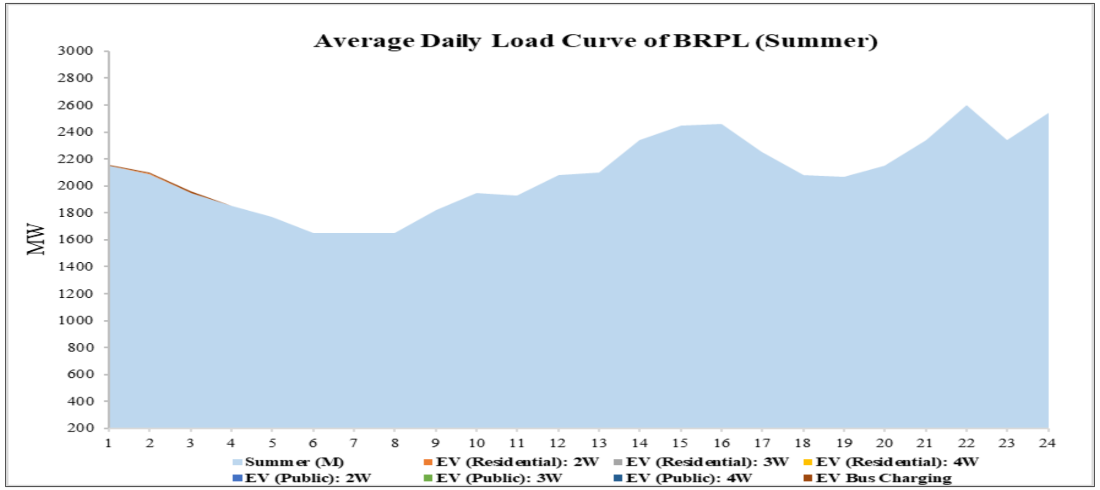


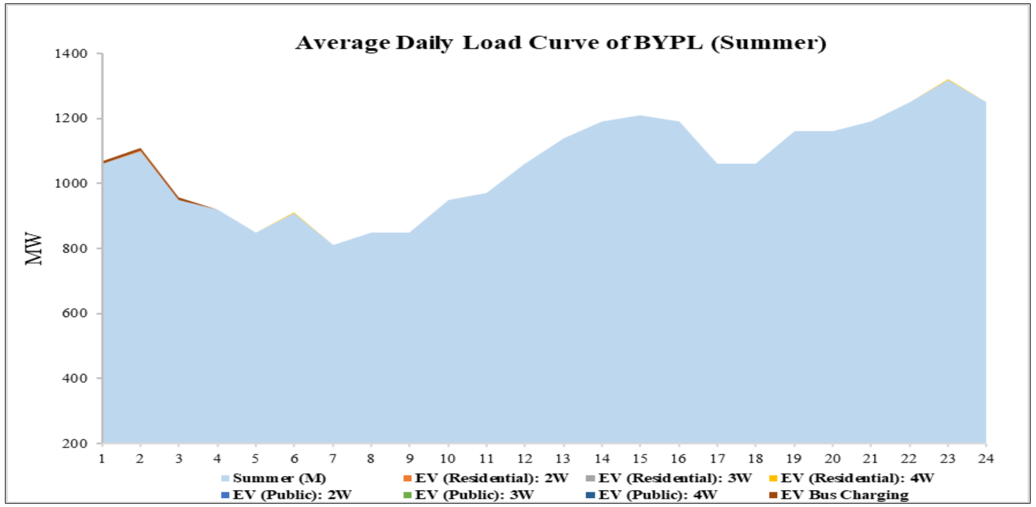


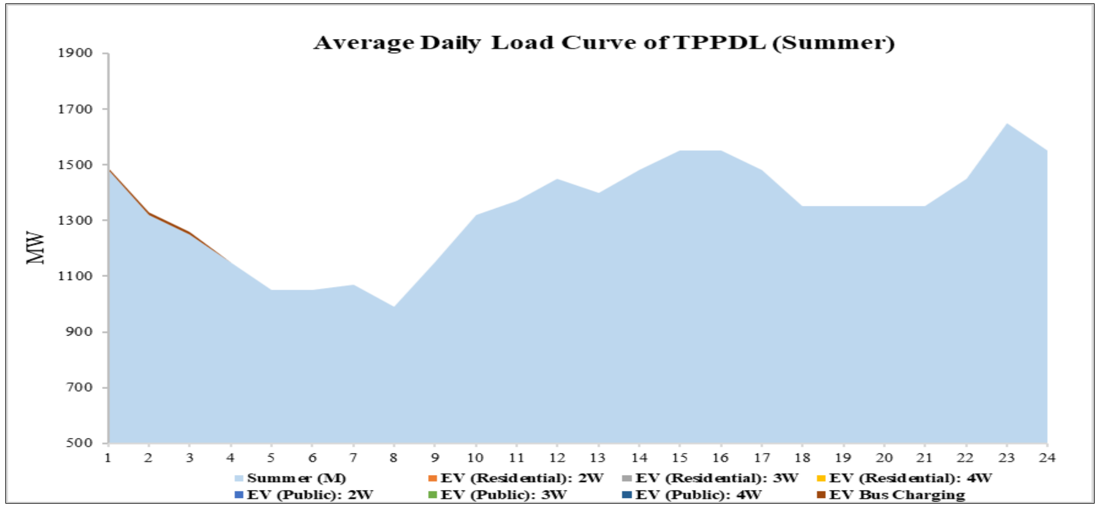
Energy consumption increase from 24% to 31% between 12 AM to 6 AM. Most of the energy consumption from EV charging is happening at home.

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

DISCOM	Number of EVs (in '000)	Additional Power Requirement for EV Charging (MW)	Increase in Energy Consumption from EVs (MWh)
NDMC	240	451	1020
BRPL	2,760	5021	11346
BYPL	1,420	2587	5846
TPDDL	2,060	3749	8473

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 form 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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