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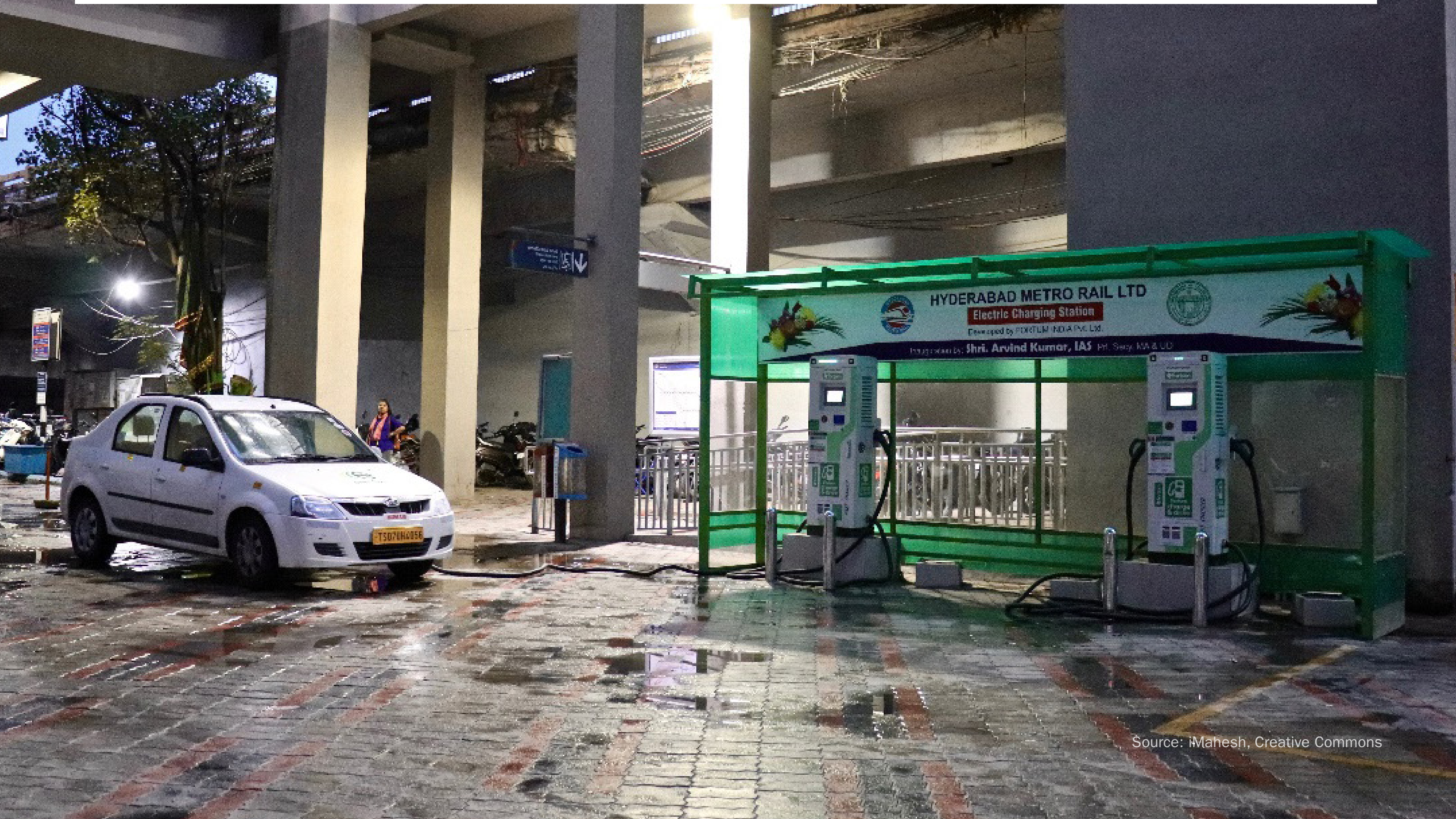
ISSUE BRIEF

Charging Forward on Powering Vehicles

Economic and Policy Drivers for Electric Vehicle Charging Infrastructure in India – Preliminary Results

A widespread, accessible public charging infrastructure network is needed to support a robust Indian electric vehicle (EV) market. To advance electric mobility in India, EV sales would need to reach 30% for private cars, 70% for commercial cars (i.e. delivery vehicles, fleets, and taxis), 40% for buses, and 80% for two- and three-wheelers by 2030 according to analysis by the Indian government.[1] Investing in the larger automotive and EV market, specifically through strong economic and policy drivers to aggressively scale-up of charging infrastructure, is critical to India's COVID-19 economic recovery, as well as, to achieve India's national goals on electric mobility, air quality and climate change.[2]

In order to attract increased investments in charging infrastructure, policy interventions are needed that can improve the economics of EVs and charging, including reducing cost hurdles and other barriers. In the absence of government policies, insufficient charging infrastructure often presents a challenge for stakeholders: a choice between building the charging infrastructure first to allow EVs to be sold or waiting for



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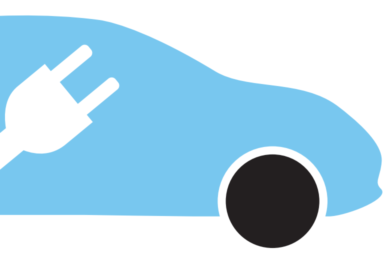
EVs to be sold prior to building charging infrastructure. This challenge is evidenced by markets in China and the United States where public charging infrastructure is a limiting factor for EV sales.[3]

This factsheet presents recommendations on economic and policy drivers for scaling-up EV charging infrastructure to support a robust EV market in India for 2-wheelers, 3-wheelers, ride-hailing vehicles, and private buses. To develop the recommendations, the Natural Resources Defense Council (NRDC) along with the Gujarat Energy Research and Management Institute (GERMI) and the Administrative Staff College of India (ASCI) conducted a model-based analysis on public charging stations in two states, Gujarat and Telangana.

Both states have draft EV policies with strong goals that are awaiting formal adoption. For example, Telangana aims to have 100% EV sales for public and shared transport by 2030.[4] Telangana also plans to provide a capital subsidy of 25% of the cost of charging equipment with a maximum of INR 500,000 ($7,100) per station for the first 500 fast charging/swapping stations.[5] Gujarat focuses on a short-term target of 100,000 EV sales, approximately 7% of overall sales, by March 2022.[6] The draft Gujarat EV policy also includes support for charging infrastructure to supplement national support under the Faster Adoption and Manufacturing of Electric and Hybrid Vehicles scheme (FAME II).[7] To accelerate charging infrastructure to support the two states' policy goals, the cities of Hyderabad and Ahmedabad, respectively, were selected for in-depth analysis given their high motorization rates.

The preliminary results and findings presented in this factsheet are based on the model analysis of the Hyderabad EV ride hailing taxi example. The analysis and policy recommendations from this example are indicative for the other vehicle segments. Since the analysis was conducted in 2019 and before the COVID-19 pandemic, some of the vehicle segment use cases have had reduced ridership, such as shared mobility and ride hailing taxis. Yet, the model analysis and recommendations are based on a long-term outlook and are still timely in laying the foundation for a robust EV market post COVID-19. The model and technical appendix with the full set of scenarios and use cases are available upon request.



To advance electric mobility in India, EV sales would need to reach 30% for private cars, 70% for commercial cars, 40% for buses, and 80% for two- and three-wheelers by 2030

PRELIMINARY RESULTS AND RECOMMENDATIONS

Operationalizing a nationwide network of accessible charging infrastructure is a crucial element of a successful ecosystem for electric mobility. To support robust infrastructure, channel public investments, and drive private financing and market-based solutions, strong policy conditions are needed. Policies that support charging infrastructure deployment, such as FAME II, are shown to be important for overcoming barriers to charging infrastructure economics.[8] However, continued and expanded policy interventions are required in order to reach 2030 EV sale goals.

An integrated and stable policy framework by the national government and states will also encourage greater engagement by private entities to establish and operate charging infrastructure. Government investment is also needed to address roadblocks, such as high upfront capital costs, that stand in the way of scaling-up electric mobility across vehicle segments in India.

Based on the model analysis, the following policy interventions would be effective in advancing the economics of charging infrastructure:

1. **Strong and integrated government policies** on electric mobility, especially on charging infrastructure, are critical. While some initial policies have been introduced, greater integration among national, state and city level policies, synergies with clean transport regulations, and engagement with crucial enablers such as power utilities and their regulators, land-owning agencies and building code regulators. are needed to give a stable policy direction.
2. **Develop utility EV programs and policies** that advance electric mobility, allow for streamlined EV grid infrastructure investments, grid connections, land availability and power management systems. As an example of the importance of utility programs, electricity costs represent 60% of the overall lifetime project costs for charging infrastructure for four-wheeler EV taxis in Hyderabad.
3. **Introduce a series of policy interventions** at the state level that work together to maximize the

economics of charging infrastructure for different vehicle segments (2-wheelers, 3-wheelers, taxis, and buses).

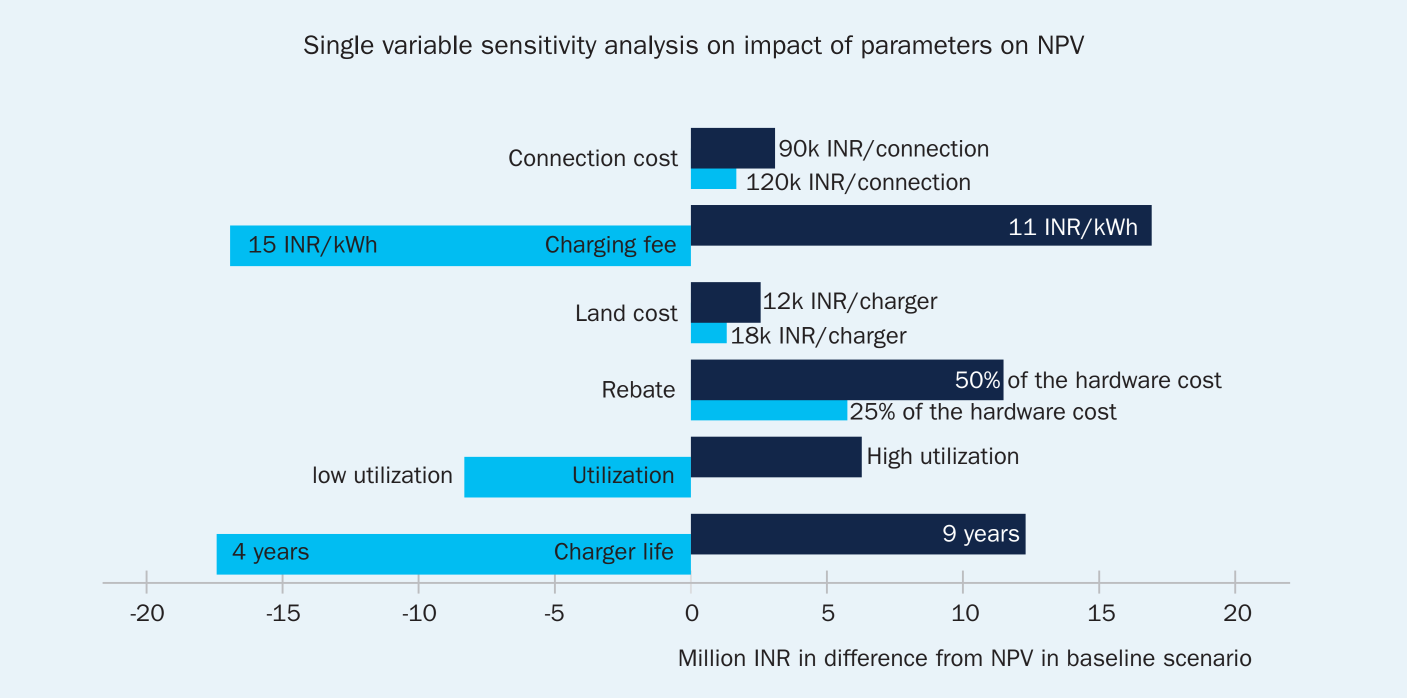
4. **Reduce upfront capital costs of hardware** for charging infrastructure through financial support, such as capital subsidies, to help reduce long payback periods ranging from 7 (taxis) to 15 (buses) years.
5. **Expedite land identification and availability** for charging location sites through incentives, such as long-term leases and lower interest rates.
6. **Provide financial assistance for grid connections** to cover the costs of EV "make-ready" infrastructure, including the costs of trenching, transformer upgrades, cables and poles.
7. **Increase access to financing** for EV charging service providers, upstream charging component manufacturers, and the retail sector to ensure wider uptake of EVs.
8. **Ensure attractive and stable electricity tariffs** for EV charging and policies, such as ToD (time of day) charging, to reduce the payback period for chargers, flatten the electricity demand peaks, improve grid stability, and reduce operational costs for EV users.
9. **Improve the utilization of charging stations** by effective siting and supportive policies, such as low emission zones, congestion pricing, and prioritizing EV parking.
10. **Streamline standards and improve reliability for charging connectors** to increase charger lifespan, reduce interoperability challenges, enhance charging station accessibility and decrease market uncertainty.

As an example, some of the key results from the preliminary model analysis of four-wheeler EV taxis in Hyderabad show that the economics of charging infrastructure are most affected by the government rebates offered, the charging service fee assessed by the service provider, and the charger lifespan (Figure 1). Land costs, station utilization rates, and the connection costs also have significant, albeit smaller, impacts to a station's economics.

EV POLICY IN INDIA – BRIEF OVERVIEW

Electric mobility in India has been dominated by two- and three-wheelers for the past decade.[9] Electric two-wheelers (scooters, mopeds, and motorcycles) and commercial three-wheelers (rickshaws and goods carriers) reached 242,000 units sold in fiscal year (FY) 2020 or about 1% of new sales of all vehicles in India.[10]

FIGURE 1: RESULTS FROM HYDERABAD EV TAXI EXAMPLE (Source: NRDC, 2020 Preliminary Analysis)



The inputs into Figure 1 are from the following sources: connection cost and charging fee reference: Fortum, personal communication, Oct. 2019; Land cost reference: EEE Taxi, personal communication, Dec. 2019; Sustainable Transportation Strategies, Site Design for Electric Vehicle Charging Stations, July 2012; Charger life reference: Ola Electric, personal communication, Nov. 2019.

FIGURE 2: SUMMARY OF RESULTS FROM POLICY INTERVENTION SCENARIO - POLICY INTERVENTION SCENARIO ASSUMPTIONS SHOWN ON LEFT, RESULTS ON RIGHT (Source: NRDC, 2020, preliminary analysis)

Reducing upfront capital cost

- Financial incentives on the hardware cost of charging infrastructure for service providers
- Rebate on the grid connection cost

Reducing the operating expenses

- Reduction in land cost - identify land parcels owned by government and lease it to the charging infrastructure providers at discounted costs and for longer time periods
- Lower electricity tariff for EV charging by introducing Time of Day (ToD) charging to manage peak power demand

Improving charger utilization

- More optimal siting of public chargers to improve charger utilization and economics
- Regulation on charging equipment lifespan to promote high - quality chargers with longer service life, reduced maintenance costs and repairs
- Ensure universal access to chargers installed by different companies to improve interoperability by introducing a common payment system
- Effective siting and supportive policies, such as low emission zones, congestion pricing, and prioritizing EV parking

Financing

- Work with banks and financing institutions to implement innovative financing mechanisms like low - interest loans (keeping in mind the low utilization of EV)

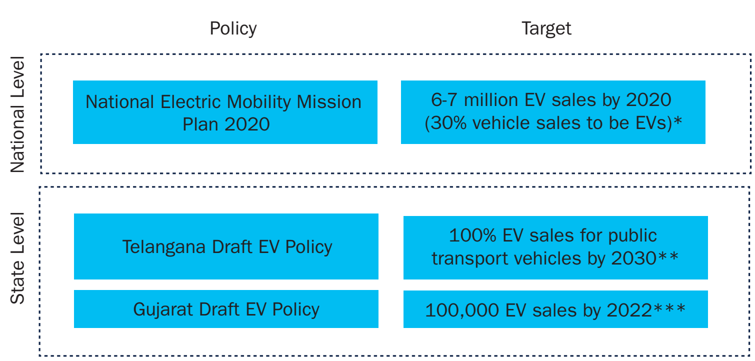
City, state and national programs are also increasing EV bus fleets for public transportation.[11]

India's electric four-wheeler market is nascent, with just 4,000 sold or less than 0.14% share of the EV market in FY2020, unlike China and the U.S., where four-wheelers (automobiles) make up a large share of the EV market.[12] For automobiles, India had a total of 1,332 public charging stations in 2019.[13]

To accelerate electric mobility, the Government of India's Phase-II of the FAME scheme created growth opportunities for EVs through demand incentives and charging infrastructure programs. FAME II plans to install 2,636 charging stations in 62 cities across 24 states and union territories in 2020, which is likely to be delayed in the short-term due to the pandemic-related economic downturn.[14] FAME II launched with a total fund allocation of INR 10,000 crores ($1.4 billion) for 1.6 million EVs between 2019 to 2022 of which INR 1,000 crores ($140 million) have been allocated for establishment of EV charging infrastructure.[15] India is also planning to bring an additional 2,600 EV charging stations online, with more expected by 2025.[16]

To advance EV sales in India, 13 states and union territories are leading the way in promoting production, services, and infrastructure.[17] According to the World Economic Forum, most of the final or draft state EV policies in India provide for the installation of charging infrastructure in public and private locations to address EV range anxiety and emphasize the services the EV value chain can provide through public awareness (e.g. how states and territories try to connect consumers and manufacturers).[18]

FIGURE 3: SUMMARY OF INDIA EV POLICIES
(Source: NRDC, 2020, preliminary analysis)



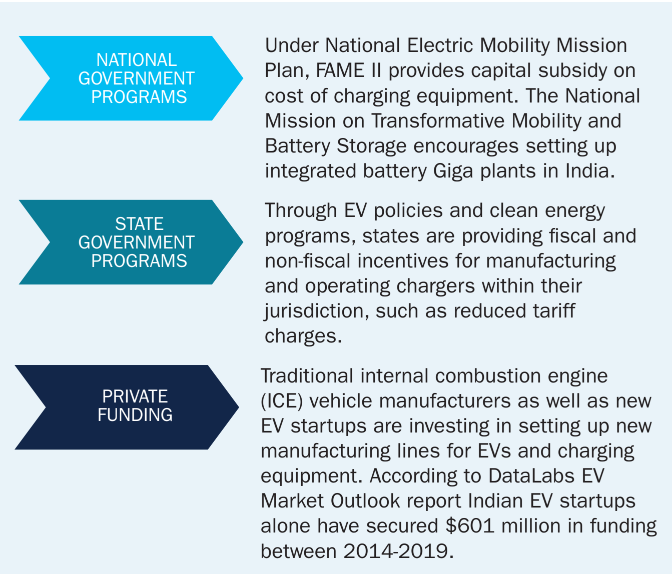
** Includes all vehicle segments.*

*** Public transport includes buses, 3W (commercial), 4W taxis*

**** 100,000 EVs include 80,000 2W, 14,000 3W, 4500 4W taxis and 1500 buses*

Funding sources for the Indian EV market include national and state programs as well as private sector investments (see Figure 4). While the COVID-19 driven economic slowdown will likely slow the short-term EV market performace, opportunities for growth in the long-term remain positive.[19] According to economic experts, an estimated 4 million electric two-wheelers and three-wheelers are projected to be sold in India by 2025.[20]

FIGURE 4: FUNDING SOURCES FOR THE INDIAN EV MARKET (Source: NRDC, 2020, preliminary analysis)



The figure above represents India's identified public and private funding sources.[21]

SCENARIOS FOR THE MODEL ANALYSIS

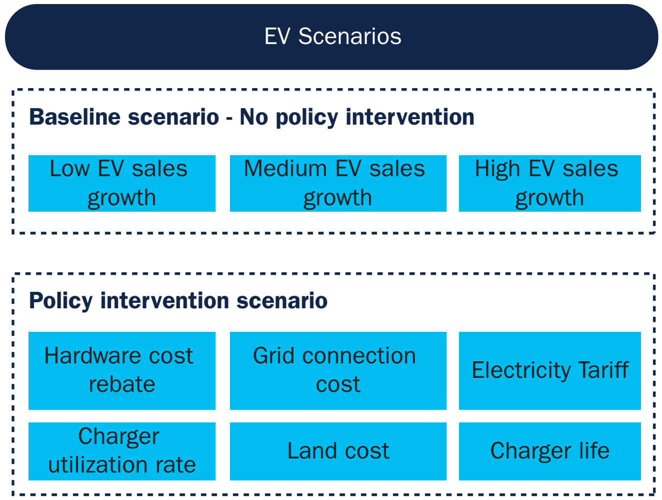
To develop the recommendations, city-specific scenarios for Hyderabad and Ahmedabad were analyzed. The preliminary results from the Hyderabad EV taxi example are presented in this factsheet.

Four EV use cases were evaluated based on FAME II incentives[22]:

- Two-wheelers (both private and commercial use)
- Three-wheelers (commercial use)
- Four-wheelers – ride-hailing companies (e.g. Uber/Ola)
- Private buses

For each EV use case, the baseline scenario and policy intervention scenario (see Figure 5) are used to show how a typical private charging service provider performs under a given market and policy environment. The differences between the two scenarios were evaluated to determine the economic performance of EV charging stations. The model ran a number of policy interventions to assess the overall impact on the net present value (NPV) and payback period (see Figure 9).

FIGURE 5: EV SCENARIOS FOR MODEL ANALYSIS
(Source: NRDC, 2020, preliminary analysis)



The figure above represents the baseline and policy interventions scenarios selected for the model analysis.

Source: Ramesh Lalwani, Flickr

Source: France in India, Flickr

MODEL SUMMARY

To identify the most attractive business and policy interventions for accelerating the deployment of EV charging infrastructure in a city or region, a financial and policy modeling tool was developed by NRDC, with modeling support by Val Hovland of Hovland Consulting and Yanbo Shu, a Stanford NRDC-Schneider Fellow. The model inputs are specific to Hyderabad and Ahmedabad, and can include transportation network companies (e.g. Ola/Uber), private four-wheelers, buses, two- and three-wheelers. Data for the modeling inputs was obtained from primary and secondary research of the Indian EV market, and through exchange with experts and state partners.

The modelling structure and methodology works as follows:

- Users input their forecast for the number of EVs in the future, which is done by using the existing historical vehicle growth trend for each vehicle segment and the vehicle targets proposed in the state-level EV policy.
- The model calculates the charging demand for these vehicles based on current EV models available in the market, as well as the driving and charging behavior of EV owners.
- After determining the type of chargers, the user selects from a number of performance metrics that serve as additional inputs to the model.
- The model is then run to find the numbers and types of chargers in such a way that maximizes the Net Present Value (NPV) of the project.
- The model provides outputs like the NPV of the project, accumulated cash flow, and payback period, which help to assess the viability of the business model under consideration.

India-specific and, when possible, city-specific inputs were used in the analysis. The data for the inputs like vehicle projections, EV models, utilization rate, discount rate and loan interest rate were obtained from secondary research of the Indian EV market. Other data points like the various costs as well as revenue factors were obtained through primary data collection by conducting interviews with charging infrastructure companies operating in India and OEMs manufacturing for the Indian market.

The full set of scenarios and use cases are described in the technical appendix. The technical appendix and the model are available upon request.

FIGURE 6: OVERALL DESCRIPTION OF THE MODEL ANALYSIS (Source: NRDC, 2020, preliminary analysis)

Predict future EV fleet
- Historic vehicle growth trend
- State/national policy target
- EV models in the market

Predict charging demand
- Vehicle battery/ performance specifics
- EV driving/ charging behaviors

Formulate business performance metrics
- Cost factors
  - Charger
  - Electricity
  - Land…
- Revenue factors
  - Energy
  - Session

Find best installation plan

Finding the numbers and types of chargers that maximizes the Net Present Value (NPV), given specific inputs and constraints

Evaluate business viability
- Estimate Net Present Value (NPV)
- Cash - flow and payback period for a project or scenario

The *baseline scenario* (where there is no policy intervention) assumes:

- No hardware cost rebate
- No subsidy on grid connection cost
- Electricity tariff = EV tariff proposed by the State Electricity Regulatory Commission
- Utilization rate which grows to a maximum of 30% utilization over the project timespan (about nine years)
- No rebate on land cost
- Charger lifespan of six years
- Mix of currently available charger types

The baseline scenario for each vehicle use case also considers the following EV sales growth rates, which align with the draft state EV policy targets: 10% EV sales (low) by 2030, 30% EV sales (medium), 50% EV sales (high), and 100% EV sales (upper bound). For Hyderabad, the medium, high, and upper bound growth rates are taken in line with the draft state EV policy.

For the model analysis for each vehicle segment, a particular EV sales percentage was projected for 2030 and policy interventions were considered for Ahmedabad and Hyderabad, see Table 1.

Source: mohitesameer285, Flickr

TABLE 1: EV USE CASE WISE SCENARIOS FOR AHMEDABAD AND HYDERABAD (Source: NRDC, 2020, preliminary analysis)

EV Use Case	City	Baseline Scenario reflecting 2030 EV sales	Policy Intervention Scenario
2W	Ahmedabad	10% and 30%	1. Charging Equipment Rebate – 50% incentive on the cost. Rebate available for 3 years. 2. Charger lifespan increased from 6 years to 9 years
	Hyderabad	30% and 100%	
3W	Ahmedabad	10% and 30%	1. Charging Equipment Rebate – 50% incentive on the cost. Rebate available for 3 years. 2. Grid connection cost per charging station reduced from INR 155,000 to 120,000 3. Charger lifespan increased from 6 years to 9 years
	Hyderabad	30% and 100%	
4W Taxis	Ahmedabad	10% and 30%	
	Hyderabad	30% and 100%	
Private buses	Charging business viability of a private bus company like Shuttl is assessed assuming it runs 300 buses on 60 routes daily. Policy interventions: 1. Charging Equipment Rebate – 50% incentive on the cost. Rebate available for 3 years. 2. Charger lifespan increased from 6 years to 9 years		

The table above represents details about the city specific scenarios for each vehicle segment. Each use case as additional assumptions. For example, the assumptions for the Hyderabad EV Taxi example are discussed below.

The *policy intervention scenario* is a state and city specific analysis that assumes the following charging infrastructure policy interventions to accelerate electric mobility in India.[23]

- Reducing upfront capital cost – by providing financial incentives on the equipment hardware cost (such as under FAME II) or the grid connection cost.
- Reducing operating expenses – by reducing the land cost, lowering the electricity tariff, introducing time-of-day (ToD) charge.
- Improving charger utilization – which can be achieved through various means by improving the charging experience of the EV user, such as – optimal siting of chargers, ensuring interoperability of chargers, improving the quality of chargers.
- Providing better and innovative financing options for EVs and electric vehicle supply equipment (EVSE).

For the policy intervention scenario, the model evaluated two types of cases: one that is consistent with FAME II timeline and the other that goes beyond the current FAME II scheme timeline. Analyses looked at the impact of each of these interventions independently, as well as grouped together as part of a scenario.

Description of Hyderabad EV Taxi Example

This factsheet presents the preliminary results and recommendation of deploying four-wheeler EV taxis in Hyderabad, as just one example. The Hyderabad EV taxi results are indicative of the results for the other use cases, as described in the appendix. Scenario results from other use cases can be found in the technical appendix, available upon request after NRDC final technical review.

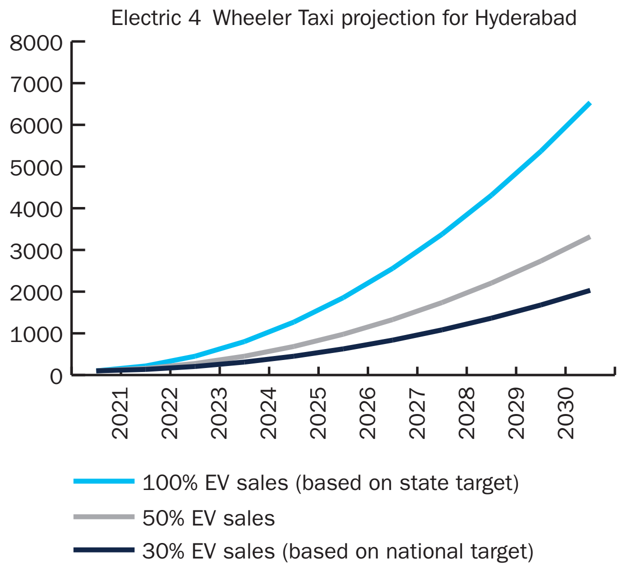
The Hyderabad four wheeler EV taxi example assumes:

- Incentives focuses on shared mobility as opposed to private vehicles (consistent with FAME II).
- EV growth is dominated by shared mobility vehicles, such as taxis.
- Taxi drivers prefer DC fast charging and utilize more "opportunity" charging during the day compared to people driving personal vehicles, according to Ola Mobility Institute, *Beyond Nagpur: The Promise of Electric Mobility*, 2019.
- Decreasing charging times allows for more rides and greater flexibility for long trips.

Generally, taxis are driven for higher vehicle kilometers compared to private vehicles, such that the economics for EV taxis are generally more attractive given the operating cost savings (including on fuel and maintenance).[24] Figure 7 below shows the growth of electric taxis in Hyderabad based on the penetrations of EVs in the total four wheelers in Hyderabad.

Source: Paul Sladen, Creative Commons

FIGURE 7: ELECTRIC FOUR-WHEELER TAXI PROJECTIONS FOR HYDERABAD (Source: NRDC, 2020, preliminary analysis)



The figure above represents the projected growth of electric taxis in Hyderabad till 2030 based on the percentage of EV sales.

For the scenario analysis, two cases are evaluated – first one consistent with the FAME II timeline and the other one consistent with the draft Telangana EV Policy, see Table 2.

TABLE 2: VEHICLE SEGMENT WISE SCENARIOS FOR HYDERABAD (Source: NRDC, 2020, preliminary analysis)

Case 1: Charger installation in first 3-years (Consistent with FAME II timeline)	Case 2: Continuous charger installation until 2030 (Consistent with Telangana Draft EV Policy)
• Project starts in 2020 • Installation occurs in the first 3 years of the charging station project • Assume chargers last 6 years, so the project concludes at year 9 i.e. 2029 • Shows how a typical private charging service company performs • Business As Usual (BAU) scenario is compared against scenarios where policy levers are applied to assess the effectiveness	• Project starts in 2020 • Installation can happen at any year until policy target year 2030 • Makes sure charging demand is met until target year 2030 • Shows the scale of investment needed to meet the policy target

The table above represents details about the city specific scenarios for four-wheeler EV taxis in Hyderabad.

Case 1: The analysis examines scenarios for EV taxis where charger installation occurs in the initial three years, which is consistent with the FAME II timeframe. The charging station project timespan is nine years taking into account the charger lifespan assumption.

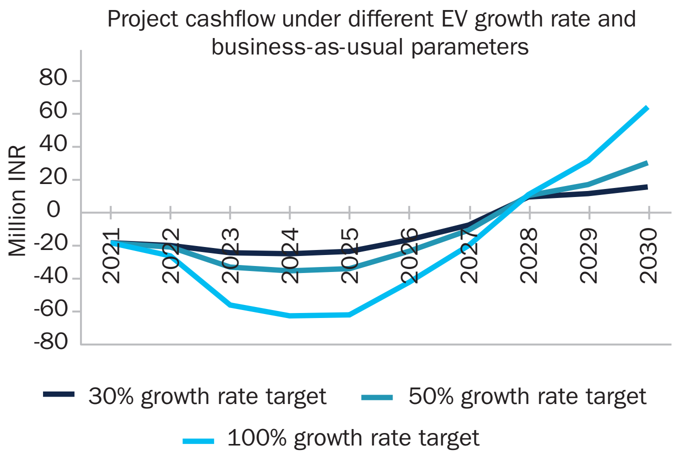
Case 2: The analysis examines scenarios for EV taxis where the chargers are installed over the charging station project timespan of eleven years to meet the charging demand for the state's 2030 EV target, calculating resources needed to meet policy targets.

RESULTS FOR HYDERABAD EV TAXI EXAMPLE

The results for case 1 (where charger installation occurs in the first three years is consistent with the FAME II timeline) for the baseline and policy scenarios.

Case 1 Baseline Scenario Results: Under the baseline scenario for case 1, service providers install chargers in first three years with a charger life of 6 years, expanding the project lifespan to 9 years. The modeling results show that a positive cashflow only begins in the 7th year, demonstrating a very difficult business case. With different EV growth rates assumed, 30%, 50%, 100%, the cashflow crossover point is not impacted; although the NPV is higher in the end under higher EV growth, because of higher charging demand from more EVs. The analyses show that the EV growth rate affects the magnitude, but not the trend and shape of the cash flow curve (see Figure 8, Project Cashflow Under Different EV Growth Rate and Business-as-Usual Parameters).

FIGURE 8: PROJECT CASHFLOW UNDER DIFFERENT EV GROWTH RATE AND BUSINESS-AS-USUAL PARAMETERS (Source: NRDC, 2020, preliminary analysis)

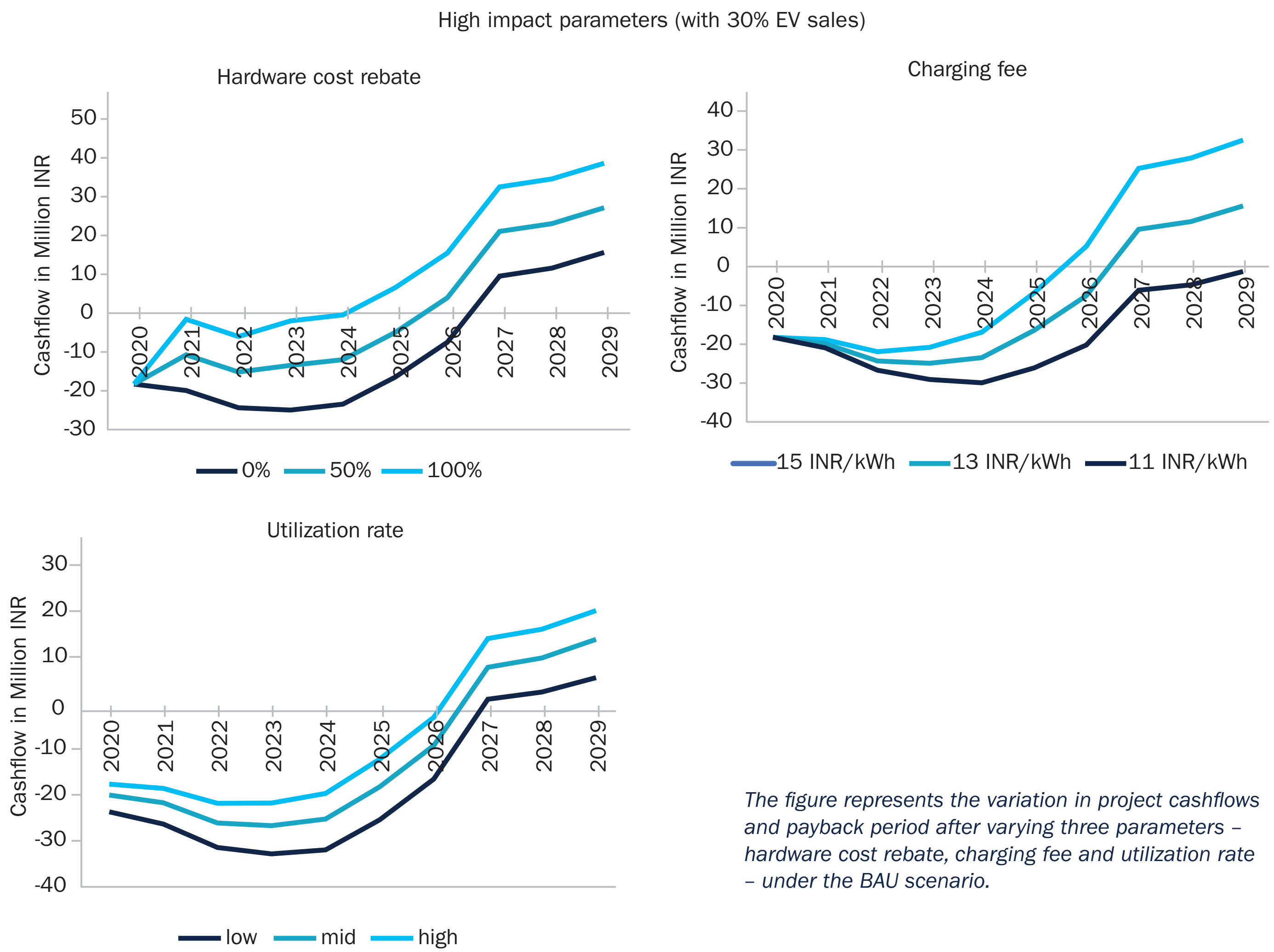


The figure above represents the project cashflows and payback period under the BAU scenario based on the percentage of EV penetration percentage.

Case 1 Policy Scenario Results: Under the policy scenario for case 1 (consistent with FAME II timelines), service providers install chargers throughout the 9 years of the project lifespan and assume that by 2030, 30% of taxis sales will be EVs. The analysis finds that 145 charging stations are needed to meet the 30% EV sales target. The policy scenario uses a single variable sensitivity analysis (only one parameter is changed at a time from the default BAU setup). Applying the 6 policy interventions (hardware cost rebates; grid connection costs; electricity tariffs; charger utilization; land costs; and charger life), the analysis found the 3 interventions were the most effective in reducing the payback period: *hardware cost rebates* (rebates help reduce upfront capital costs that are higher in the initial years); *electricity tariffs* (lower electricity tariffs help reduce the operating costs and fees charged to customers); *charger utilization* (maximizing the use of chargers in terms of the number of customers per day is critical improving the financial viability). The main findings for case 1 policy scenario are (see Figure 9):

- A positive cash flow is achieved in 4 years if the rebate covers 100% of the hardware costs (as offered under FAME II scheme for chargers installed in government buildings).
- Hardware cost, charging fee, utilization rate impact positive cashflow the most.
- A strong set of policy interventions of 100% hardware cost rebate and an additional 2 INR/kWh margin between electricity tariff and charging fee will be effective in yielding positive cash flows in three years.
- Increases in the charging fees is limited by the EV customer's willingness to pay, and the electricity tariff is bound by the utility's cost to provide electricity.
- Land costs, the charger lifespan, and the connection cost have a smaller but significant impact.

FIGURE 9: PROJECT CASHFLOW UNDER DIFFERENT POLICY INTERVENTIONS IN THE BUSINESS-AS-USUAL SCENARIO
(Source: NRDC, 2020, preliminary analysis)



The figure represents the variation in project cashflows and payback period after varying three parameters – hardware cost rebate, charging fee and utilization rate – under the BAU scenario.

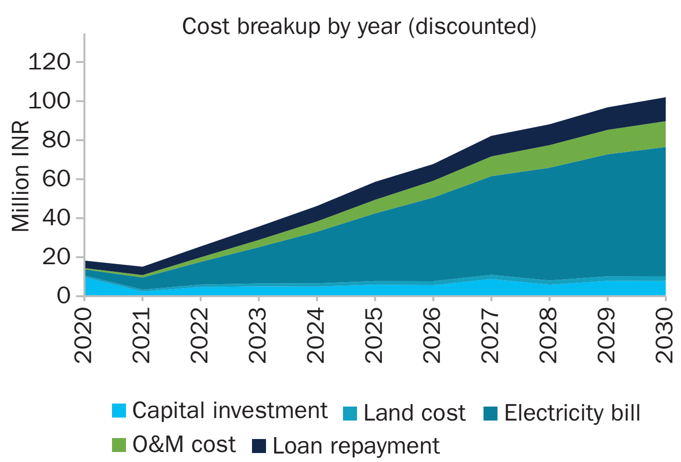
The results for case 2 (where charger installation occurs anytime from 2020 to 2030 and is consistent with the draft Telangana EV Policy) policy scenario.

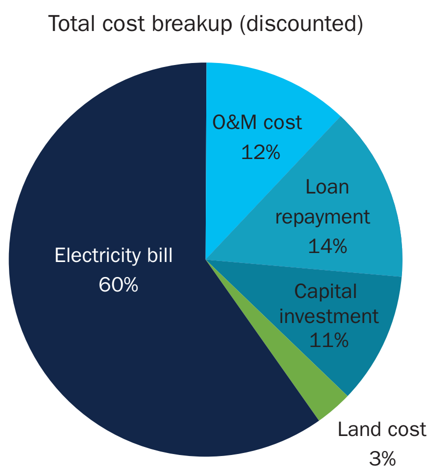
For case 2, the baseline (BAU) results are similar since there are no policy interventions in either. The results here focus on the policy scenario.

Case 2 Policy Scenario Results: The analysis for Hyderabad based on the draft Telangana 2030 policy targets (100% EV sales for four-wheel taxis) is covered here (see Figure 10.) The analysis finds that nearly 510 chargers are needed between 2020 to 2030 to meet the charging demand from an entirely electric taxi fleet for Hyderabad. The ratio between public chargers and taxis will be about 1:10. For context, the ratio for EVs to public chargers in California is 1:26 EVs and Beijing is 1:5; EU countries are establishing targets for one publicly accessible charging outlet for every 10 cars by 2020.[25] The main findings are:

- A positive cash flow is achieved in 4 years if the rebate covers 100% of the hardware costs (as offered under FAME II scheme for chargers installed in government buildings).
- Hardware cost, charging fee, utilization rate impact positive cashflow the most.
- To meet the charger requirements, investments from both private and public sectors, and especially from utilities, is needed.
- Capital investment and ongoing cost (present value) will be about 640 million INR ($8.6 million) from 2020 to 2030 to establish (install) and operate the charging infrastructure network.
- Investments will lead to creation of jobs (in construction and operation), and in the end the charging infrastructure will create positive monetary value of 65 million INR (NPV).
- The cost structure shows that 60% of the project cost is from energy (i.e. electricity bill from utilities), which is about 380 million INR ($5.1 million), indicating that charging infrastructure can be an attractive revenue source for utilities.
- Hardware cost dominates the first few years, however, energy cost dominates afterwards.

FIGURE 10: RESULTS FOR ACHIEVING TELANGANA'S DRAFT STATE POLICY TARGET FOR 2030 (100% ELECTRIC TAXIS IN HYDERABAD) (Source: NRDC, 2020, preliminary analysis)





The graph above depicts the year wise project cost breakup for setting up charging stations for 100% electric taxi fleet in Hyderabad by 2030. The pie-chart represents the cost breakup over the entire timespan of the project.

Source: Greg Geobel, Creative Commons

MODEL INPUTS

1. Electric vehicle projections
2. Electric vehicle models (specifying electric range, battery capacity, max, charging capability)
3. Annual utilization rate of installed EV Chargers
4. Costs:
    - Cost and KW rating of charging equipment (INR)
    - Power grid upgrade cost (INR/connection)
    - Land cost (INR/sqft/month)
    - Labor & materials cost (INR/connection)
    - Payment system cost (INR/kWh)
    - Maintenance cost (INR/kWh)
    - Electricity rate (INR/kWh)
5. Charger installation time span (years)
6. Charger life span (years)
7. Years meeting demand after installation (years)
8. Discount rate (%)
9. Loan interest rate (%)
10. Loan tenure (years)
    - Charging fee (INR/kWh)
    - Session fee (INR/session)
    - Idie fee (INR/hr)

ENDNOTES

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2 Better India, Three Things Governments Will Have to Focus on to Fight Climate Change Post COVID 19, July 2020, https://www.thebetterindia.com/233039/environment-impact-climate-change-covid-19-post-coronavirus-india-experts/

3 NRDC, ASCI, GERMI, Scaling Up Electric Vehicle Charging Infrastructure: Lessons from China and the United States for the Indian Context, July 2020

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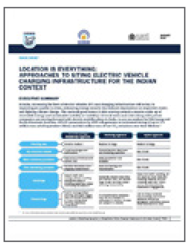

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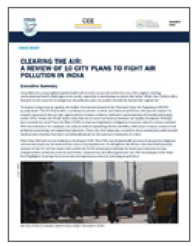

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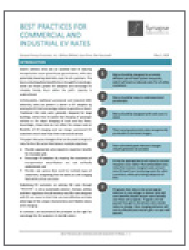

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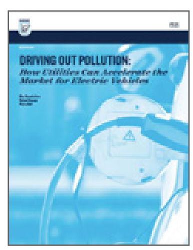

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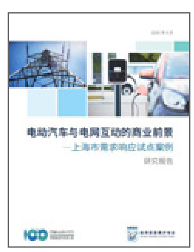

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