Practitioner's Guide for Deployment of Public Charging Stations for Electric Vehicles

Learnings from first large-scale roll-out of public charging stations by EESL

January 2020

This report is made possible by the support of the American people through the United States Agency for International Development (USAID). The contents do not necessarily reflect the views of USAID or the United States Government.

Acknowledgements

This report was prepared under USAID's Smart Power for Advancing Reliability and Connectivity (SPARC) Program. The implementation partner of the USAID's SPARC Program is KPMG Advisory Services Pvt. Ltd. (KASPL).

The USAID's SPARC Program would like to thank Saurabh Kumar, Managing Director, EESL for his vision and leadership to make Electric Vehicles (EVs) a practical reality in India. The Program would also like to thank EESL officials: D.G. Salpekar, Chief General Manager; N.Mohan, Deputy General Manager (Head, EV Charging Infrastructure); Aanchal Kumar, Officer (Environment); Archana Chauhan, Engineer (Technical); and others who provided technical inputs.

The USAID's SPARC Program would like to express its sincere appreciation and gratitude to the experts in New Delhi Municipal Council (NDMC). The Program would particularly like to acknowledge the guidance of Dharmendra, Chairman; Naresh Kumar, former Chairman; and A.K. Joshi, C.E. (E-II) along with NDMC officials: Chaman Lal, Rajesh Mathuria; Deepak Sachdeva, Khalid Iqbal, Balbir Singh, Sunil Kumar, Ashok Kumar, and others.

The report substantially benefited from inputs provided by officials of Chennai Metro Rail Limited, Jaipur Metro Rail Corporation, Jaipur Vidyut Vitran Nigam Limited, South Delhi Municipal Corporation, and Gurugram Metro Development Authority.

USAID/India

Michael Satin

Apurva Chaturvedi

USAID's SPARC Program

Vikas Gaba

Saurabh Gupta

Sourabh Mukherjee

Prakash Powdel

Rajesh Singla

Madhur Kapoor

MESSAGE

Energy is a core element of the U.S.-India strategic partnership. USAID has long-standing partnership with the Government of India through its various bilateral initiatives on energy.

It is exciting to see the market landscape for electric vehicles (EVs) evolving. Government incentives, emerging technologies and declining prices are encouraging more people to ride the EV boom globally.

India's push for EVs is coming from several directions: the need to tackle local air pollution, reduce reliance on fuel, and decarbonize its road transport. New EV commitments are being announced regularly—be it related to policy, technology, finance or partnerships.

The United States Agency for International Development (USAID), through its Smart Power for Advancing Reliability and Connectivity (SPARC) Program, is supporting the development of an enabling environment for EV infrastructure in the country. As a part of this initiative, the Program is providing technical assistance to Energy Efficiency Services Limited (EESL) on public charging stations.

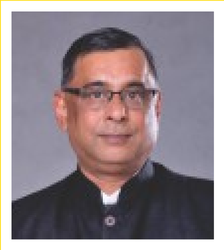
At USAID we strive to look beyond the traditional business models and pursue innovation and novel approaches. The project for public charging stations in New Delhi, rolled out in partnership with EESL, is a key example. This set of installations is one of the largest public charging station programs in India.

We are hopeful that the knowledge creation and capacity building regarding the scalable business model, site assessment, end-use pricing mechanism and partnerships established in the demonstration project will help scale up EV adoption not only in India but serve as a model for other South Asian countries as well.

I would like to express my sincere appreciation and thanks to our bilateral partner, the Ministry of Power and EESL's dynamic leadership in consistently breaking barriers and transforming markets.

Michael Satin
Director - Clean Energy and Environment Office
USAID/India

U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT
American Embassy
Chanakyapuri
New Delhi 110 021   Tel: 91-11-24198000   Fax: 91-11-24198612
www.usaid.gov/in



Saurabh Kumar
Managing Director
Energy Efficiency Services Limited (EESL)

Foreword

Deployment of Electric Vehicles (EVs) is a key priority for the Government of India. The Government has undertaken several policy and regulatory initiatives incorporating incentives for accelerated adoption of EVs. Three key initiatives undertaken are a) notification of Phase-II of Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) scheme to stimulate the market of EVs in the country; b) de-licensing the charging infrastructure business thereby opening up the market of public charging infrastructure to all players, and c) rationalizing the taxes on EV to reduce upfront cost of EVs.

Energy Efficiency Services Limited (EESL), working under the Ministry of Power, has been anchoring the EV ecosystem development in India through its National e-mobility program launched in 2018. The goal of the e-mobility program is to provide an impetus to Indian EV manufacturers, charging infrastructure companies, fleet operators, service providers, etc. to gain efficiencies of scale and drive down costs, create local manufacturing facilities, and grow technical competencies for the long-term growth of EV market.

EESL is pleased to partner with USAID's Smart Power for Advancing Reliability and Connectivity (SPARC) Program for undertaking a first of its kind project in Delhi that has helped demonstrate an innovative and sustainable EV charging business model. The project supported installation of more than 55 Public Charging Stations in New Delhi, becoming one of India's largest such programs. The project demonstrated leveraging the various synergies and the developing key understanding of location assessment and pricing mechanism which I am confident will help in further roll-out of Public Charging Stations throughout the country in line with the vision of the Government of India. I would like to acknowledge the contributions of all the stakeholders involved in the project.

EESL remains committed to promote e-mobility in India. We now plan to install deploy more than 1,500 Public Charging Stations in 13+ cities. Increased adoption of EVs will help India reduce its local air pollution level.

CONTENTS

List of Figures and Tables

List of Abbreviations

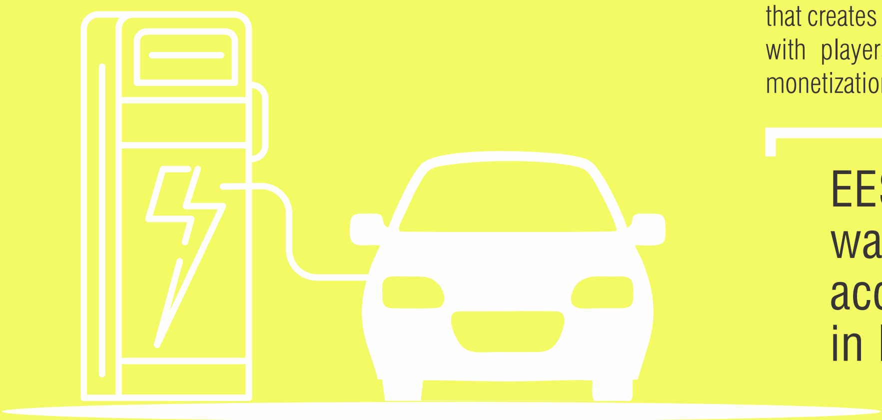
CCS	Combined Charging System
CHAdeMO	CHArge de Move
CMS	Charger Management System
EESL	Energy Efficiency Services Limited
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
FAME	Faster Adoption & Manufacturing of (Hybrid &) Electric Vehicles
GOI	Government of India
ICE	Internal Combustion Engine
IEA	International Energy Agency
MOP	Ministry of Power
NDMC	New Delhi Municipal Council
OEM	Original Equipment Manufacturer
PCS	Public Charging Station
POI	Point of Interest
SDMC	South Delhi Municipal Corporation
SERC	State Electricity Regulatory Commission
SOC	State of Charge
SPARC	Smart Power for Advancing Reliability and Connectivity
UJALA	Unnat Jyoti by Affordable LEDs for All
USAID	United States Agency for International Development
ZEV	Zero Emission Vehicle

EXECUTIVE SUMMARY

The global Electric Vehicle (EV) market is experiencing a steady growth. Governments across the globe are providing incentives to promote the adoption of EVs to improve local air quality and minimize dependence on fossil fuel. At their end, automobile makers and components manufacturers are also gearing up for the EV push, bringing in competition and economies of scale – making EVs more affordable.

The Indian story is no different. The Government of India (GOI) has accelerated its efforts towards large-scale deployment of EVs by devising policies and programs around three critical interventions: (i) creation of demand; (ii) creation of supply; and (iii) development of public charging infrastructure.

Energy Efficiency Services Limited (EESL), a joint venture of state-owned public enterprises, is anchoring the EV ecosystem development in India. EESL launched its National e-mobility programme in March 2018 with the key aim of establishing an enabling ecosystem for EVs.



The United States Agency for International Development (USAID), under its bilateral program with the Ministry of Power (MOP), titled Smart Power for Advancing Reliability and Connectivity (SPARC)*, is assisting EESL to develop and implement a scalable business model for deployment of Public Charging Station (PCS).

As a part of this initiative, EESL, in partnership with the USAID's SPARC Program, designed and implemented a first-of-its-kind large-scale roll-out of PCS project in New Delhi Municipal Council (NDMC) region. The project demonstrated a scalable business model and standard framework for deployment of PCS in India.

From using its proven demand aggregation model for bulk purchase of EVs to adopting innovative business models for installations of PCS to partnering with private players, EESL is pioneering new ways for pushing the accelerator on e-mobility in India.

This report summarizes the key highlights of the project, and the learnings from the initial installations along with the outcomes. It also lists the critical requirements for a sustainable PCS business. These include: detailed site assessment for identifying suitable locations, business model that creates win-win scenario for all stakeholders, partnerships with players to ensure utilization, and avenues for asset monetization, among others.

> EESL is pioneering new ways for pushing the accelerator on e-mobility in India.

*USAID launched the SPARC Program in partnership with the Ministry of Power, Government of India in 2018. SPARC is a three-year initiative with the objective of supporting the transformation of operational and financial performance of electricity distribution utilities and facilitating an enabling environment for EVs in India. The implementing partner of the SPARC Program is KPMG Advisory Services Pvt. Ltd.

LARGE-SCALE ROLL-OUT OF
PUBLIC CHARGING STATIONS FOR ELECTRIC VEHICLES

A joint initiative of EESL and USAID's SPARC Program

KEY OBJECTIVE Business model and deployment strategy for installing Public Charging Stations (PCS) in India

Business Model Design and Cost Economics

Business model
Designed a business model which created a win-win proposition for all.

Cost economics
Studied the core elements of cost and revenue for all charger types and calculated PCS service fee.

Pricing mechanism
Identified global best practices for pricing mechanism.

Location Assessment and Installation

Framework for location assessment
Devised a framework for location assessment, including site specific conditions and footfall.

Field visit
Visited each site to study the feasibility of PCS installation.

Prioritization of sites
Categorized the sites as Priority 1, 2 and 3 based on the ease of implementation.

Installation
Considered Priority 1 and 2 sites for installation of PCS.

User Interface and EV Analytics

Mobile app
Ensured that all charging stations were operated through a mobile app, enabling EV users to book chargers in advance and pay online.

Dashboard for data and analytics
Developed Charger Monitoring Dashboard (ChargeD) for monitoring key parameters such as utilization and energy consumption.

Scaling-up & Development of EV Ecosystem

Capacity building
Training and hand-holding of EESL officials to help them carry out location assessment in their respective areas.

Partnership
Identified partnership opportunities for EESL to ensure PCS business sustainability.

Avenues for asset monetization
Identified avenues for non-tariff revenue through marketing/advertisement rights to minimize utilization risk and improve affordability for PCS service fee.

KEY OUTCOMES

PCS in New Delhi
- 55+ Public charging stations
- 42,000+ Units of electricity consumed (May-Dec 2019)
- 250,000+ km supported (May-Dec 2019)*

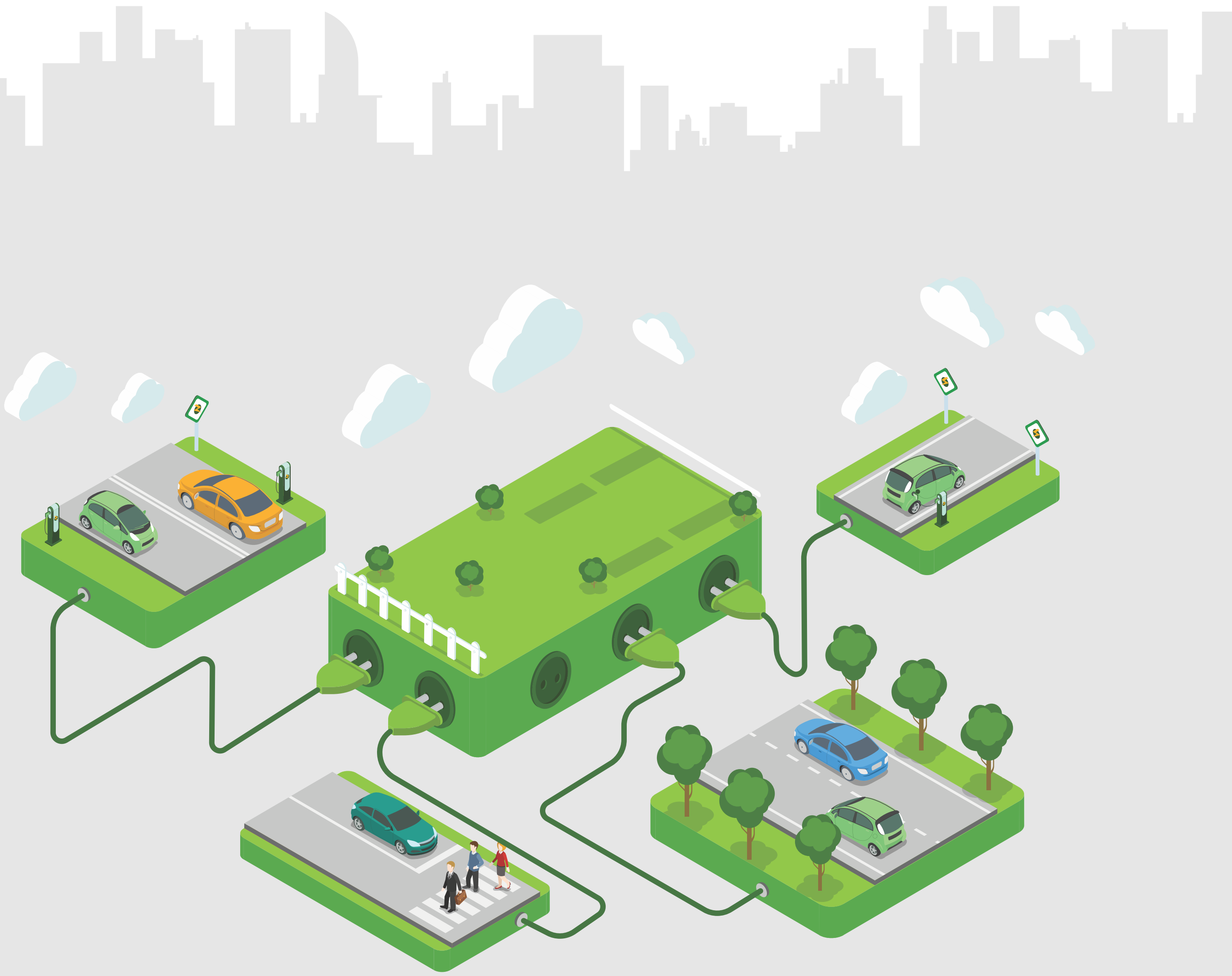
Scale-up tools and templates
- Scalable business model
- Standard location assessment methodology
- Standard offer and checklist for PCS installation
- MOU/agreement templates for partnerships
- Charger Monitoring Dashboard "ChargeD"

Partnerships
- 16+ Land-owners
- 4+ Power distribution utilities
- 1+ EV OEMs
- 2+ Cab aggregators

*Assuming mileage of 6 km/kWh

CRITICAL REQUIREMENTS FOR A SUSTAINABLE PCS BUSINESS

- Detailed location assessment for identifying most suitable locations
- Access to sufficient land and power load for setting up charging stations
- Business model exploring synergies and creating win-win scenario for all
- Combination of centralized (one location with multiple chargers) and decentralized (locations with one or two chargers) charging stations
- Pricing mechanism for PCS assuring recovery of investment in PCS business
- Partnerships to improve utilization and improve affordability for users
- Avenues for generating non-tariff revenue to improve profitability



01

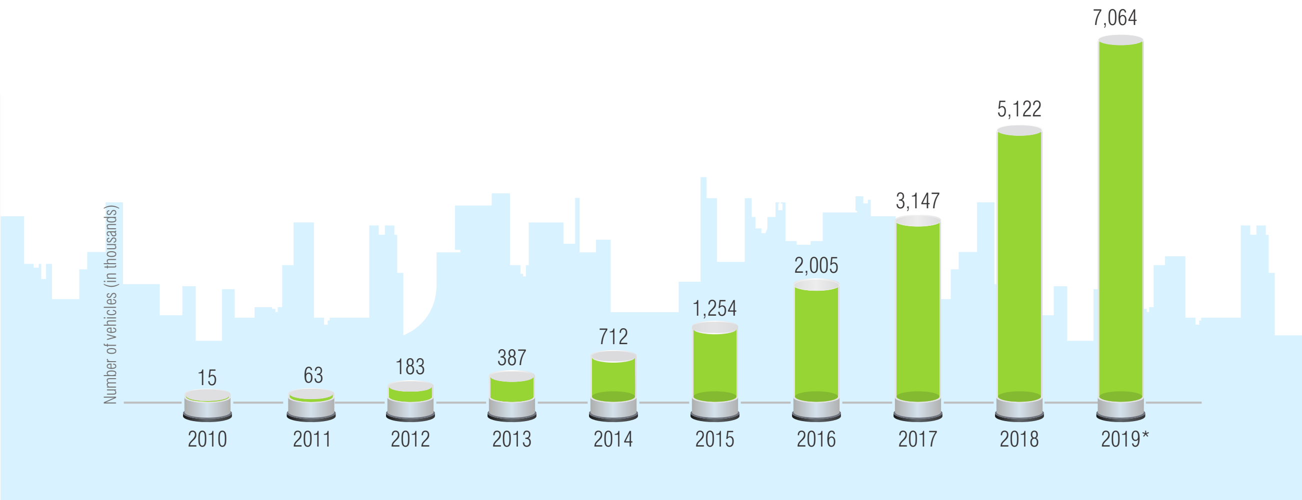
INTRODUCTION

1.1. Global Push for EVs

The global EV market is at the herald of a new beginning. Decreasing cost of lithium ion batteries [1] and policy push by several countries increased the global EV sales to 2 million mark in 2018 from less than 50,000 in 2010 [2]. By November 2019, the total global EV stock reached 7 million [3] from mere 15,000 at the start of the decade as depicted in Figure 1 [2]. Based on existing and newly-announced policies across the globe, the International Energy Agency (IEA) estimates there will be 130 million EVs on the road by 2030 [2].

Global EV sales crossed 1 million mark in 2017 and touched 2 million mark in 2018. IEA estimates 130 million EVs to be on the road by 2030.

Figure 1: Global Stock of Four-Wheeler EVs [2]



*Till November 2019 [3]

The People's Republic of China emerged as the world's largest EV market accounting for more than 2 million electric cars, 99% of global e-bus market, and 250 million electric two-wheelers [2]. Norway emerged as the global leader in terms of penetration of electric cars – as overall market penetration of EVs crossed 50% in 2019[1] [4] and reached an all-time high of almost 70% in March 2019 [5].

Governments across the globe are promoting EVs largely due to the accrued benefits such as improvement in local air quality, reduction in fuel requirement, and enhanced energy security. Their focus is on a cohesive approach with interventions both at the demand and supply side that can develop an enabling EV ecosystem. This includes:

a) Incentivizing Demand

Upfront cost of an EV is significantly higher than the cost of an Internal Combustion Engine (ICE) vehicle. To address this challenge, governments are rolling out various incentives. Direct financial incentives include tax credits, low registration charges, custom duty exemption, upfront capital subsidy, etc. while other incentives include free/discounted parking, privileged access to congestion zones, access to bus and taxi lanes, etc.

b) Creating Supply

There are limited EV models currently available in the market. Policy makers are developing schemes/mandates for Original Equipment Manufacturers (OEMs) to introduce more EV models in the market. Several countries have adopted Zero Emission Vehicle (ZEV) mandate to nudge OEMs to manufacture/supply more EVs. For instance, ten states in the U.S. have adopted ZEV mandate under which 22% of the vehicles produced by intermediate and large volume OEMs need to be ZEVs by 2025 [6].

c) Developing Charging Infrastructure

A key barrier in EV adoption is "range anxiety" whereby an EV user fears whether his/her vehicle has enough charge to reach the desired destination. A wide network of public charging infrastructure is therefore required to alleviate the range anxiety among people. To promote investment in EV public charging infrastructure, authorities in several countries have mandated to mark out space for EV parking and charging in new buildings, invested in creation of charging infrastructure, and announced financial incentives for installation of charging stations. Some countries have also set standardized protocols related to charging infrastructure. For instance, China has adopted a single nationwide EV fast charging standard (GB/T) [7], and Norway has adopted a universal charging tag for easier access and payment.

A wide network of public charging infrastructure is required to alleviate range anxiety among people.

Some of these interventions are briefed in Figure 2.

[1] Till October, 2019

Figure 2: Interventions for Development of EV Ecosystem

1. Incentivizing demand

- Incentive to purchase: Incentives to minimize high upfront cost, low registration taxes, no annual fees, etc.
- Other incentives: Incentives such as privilege access, free parking, etc.

2. Creating supply

- Incentives: Incentives to support R&D, manufacturing, imports of EVs
- Mandates: Mandate to manufacture a certain percentage of vehicles as EVs

3. Developing charging infrastructure

- Market enabler: Government departments, leading installation of PCS as a market creator
- Financial incentives: Incentives for installation of charging stations
- Standard protocols: Standardizing protocols for cohesive development of EV market
- Mandates: Mandates to create provision for charging infrastructure in residential/commercial buildings

1.2. The Indian Story

The Government of India (GOI) is proactively working towards large-scale deployment of cleaner mobility solutions in the country, including deployment of EVs. Figure 3 provides a timeline of the key measures undertaken by the central and state governments, and regulatory institutions to promote EVs in recent years. EV adoption targets as set by various state governments are provided in Box 1.

Figure 3: Various Measures to Promote EVs

2010

- Alternative Fuel for Surface Transportation Programme launched by Ministry of New and Renewable Energy, GOI
- Programme to support R&D for developing advanced batteries, super capacitors and components of EVs and pilot projects in e-mobility

2012

- Department of Heavy Industry launched National Electric Mobility Mission Plan 2020
- Target set to achieve total sale of 6-7 million hybrid and electric vehicles by 2020

2015

- Department of Heavy Industry announced Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India (FAME) Scheme
- FAME-I Scheme launched with budget outlay of INR 795 crores for two years. Same was extended till March 2019

2017

- EV policies (final or draft) announced by governments of Karnataka and Telangana
- Karnataka became the first state to announce state policy for EVs

2018

- EV policies (final or draft) announced by governments of Andhra Pradesh, Delhi, Kerala, Maharashtra, and Uttar Pradesh.
- Setting up PCS declared as a de-licensed activity by the MOP
- Green registration plates for EVs announced by Ministry of Road Transport and Highways
- Charging infrastructure for EVs – Guidelines and Standards released by the MOP
- Notification by various State Electricity Regulatory Commissions (SERCs) for special power tariff category for EV charging

2019

- EV policies (final or draft) announced by governments of Bihar, Gujarat, Madhya Pradesh, and Tamil Nadu.
- Phase II of FAME scheme launched with budget outlay of INR 10,000 crores for three years
- National Mission on Transformative Mobility and Battery Storage announced
- Phased Manufacturing Plan announced to promote indigenization of EV manufacturing
- Custom duties on EVs and related component reduced
- Goods and Services Tax on EVs cut to 5% from 12%
- Income tax rebates of up to INR 1.5 lakh announced to customers on interest paid on loans to buy EVs
- Notification by various SERCs for special power tariff category for EV charging
- Model Building Byelaws 2016 & Urban Regional Development Plans Formulation and Implementation Guidelines 2014 amended for establishing EV charging infrastructure

Box 1: Snapshot of EV Targets of Selected States in India [8]

Andhra Pradesh	10 lakh EVs on road in the next 5 years
Bihar	100% e-mobility adoption of 3-wheelers/rickshaws by 2022
Delhi	25% EVs for all new vehicle registrations by 2023
Gujarat	100,000 EVs by 2022
Karnataka	100% migration to EVs by 2030
Kerala	1 million EVs on road by 2022
Madhya Pradesh	25% EV adoption by 2024
Maharashtra	500,000 EV registrations in next 5 years
Uttar Pradesh	100% migration to EVs by 2030 in 5 cities
Tamil Nadu	100% adoption of EVs for all taxis, app-based aggregators & rickshaws in 6 cities by 2029
Telangana	100% migration to EVs by 2030

These initiatives have encouraged several OEMs to introduce new EV models in the Indian market. Several players (private as well as state entities) have also announced plans to roll-out large-scale charging network in the country.

1.2.1. EESL: Anchoring India's Vision for EVs

EESL[2] is anchoring the EV ecosystem development in India by undertaking demand aggregation for procuring EVs and identifying innovative business models for implementation of PCS.

Box 2: National e-mobility Programme of EESL

The National e-mobility Programme of EESL was launched in March 2018 by the Hon'ble Minister of Power and New and Renewable Energy. The goal of this programme is to provide an impetus for Indian EV manufacturers, charging infrastructure companies, fleet operators, service providers, etc. to gain efficiencies of scale and drive down costs, create local manufacturing facilities, and grow technical competencies for the long-term growth of the EV industry in India. The programme also aims to facilitate Indian EV manufacturers emerge as major global players.

EESL is replicating its successful demand aggregation business model to procure EVs. Under its National e-mobility Programme (as briefed in Box 2), EESL has aggregated the demand of EVs and chargers from various government departments/agencies such as the Prime Minister's Office, Fifteenth Finance Commission, MOP, NITI Aayog, NDMC, South Delhi Municipal Corporation (SDMC), Gurugram Metro Development Authority, NTPC, among others to provide EVs and charging infrastructure. In order to meet the demand, EESL issued a tender to procure 10,000 EVs and 2,125 chargers in 2017 [9]. It has already deployed more than 1,500 EVs and 470 chargers across the country as of November 2019 [9]. The chargers installed by EESL were mostly within office complexes and societies for captive use. This left out a range of general public and commercial EVs that require regular charging.

To address this gap, EESL is pioneering an initiative for large-scale deployment of PCS in India. A wide network of PCS would not only ease range anxiety of existing EV owners but also encourage others to adopt EVs. Box 3 provides an overview of EESL's partnership with USAID on the large-scale deployment of PCS.

Box 3: EESL-USAID Partnership on large-scale deployment of PCS

In 2018, EESL partnered with the USAID's SPARC Program to develop and implement a scalable business model for PCS. As a part of this initiative, the Program provided technical assistance to EESL in structuring a first-of-its-kind large-scale roll-out of PCS in New Delhi. The assistance included design of business model, location assessment, feasibility assessment and implementation support. The Program also supported EESL to create an enabling EV ecosystem by establishing partnerships with electricity distribution utilities, municipal corporations, and private sector players including fleet operators, metro rail corporations, etc.

The standard methodology, documents and capacity building undertaken as a part of the Program has helped in smoothing the initial challenges and identify best practices. These have also significantly simplified the process of designing and deploying PCS in a time and cost-effective manner. As of December 2019, EESL has installed more than 55 PCS in New Delhi. EESL now has aggressive plans to scale to more than 13 cities.

[2] EESL is a joint venture of state-owned public enterprises: NTPC Limited, Power Finance Corporation, Rural Electrification Corporation and POWERGRID Corporation of India Limited. The organization is renowned for successfully implementing large-scale energy efficiency programs across sectors such as buildings, e-mobility, smart metering and agriculture.

1.3 Large-scale roll-out of PCS by EESL in New Delhi

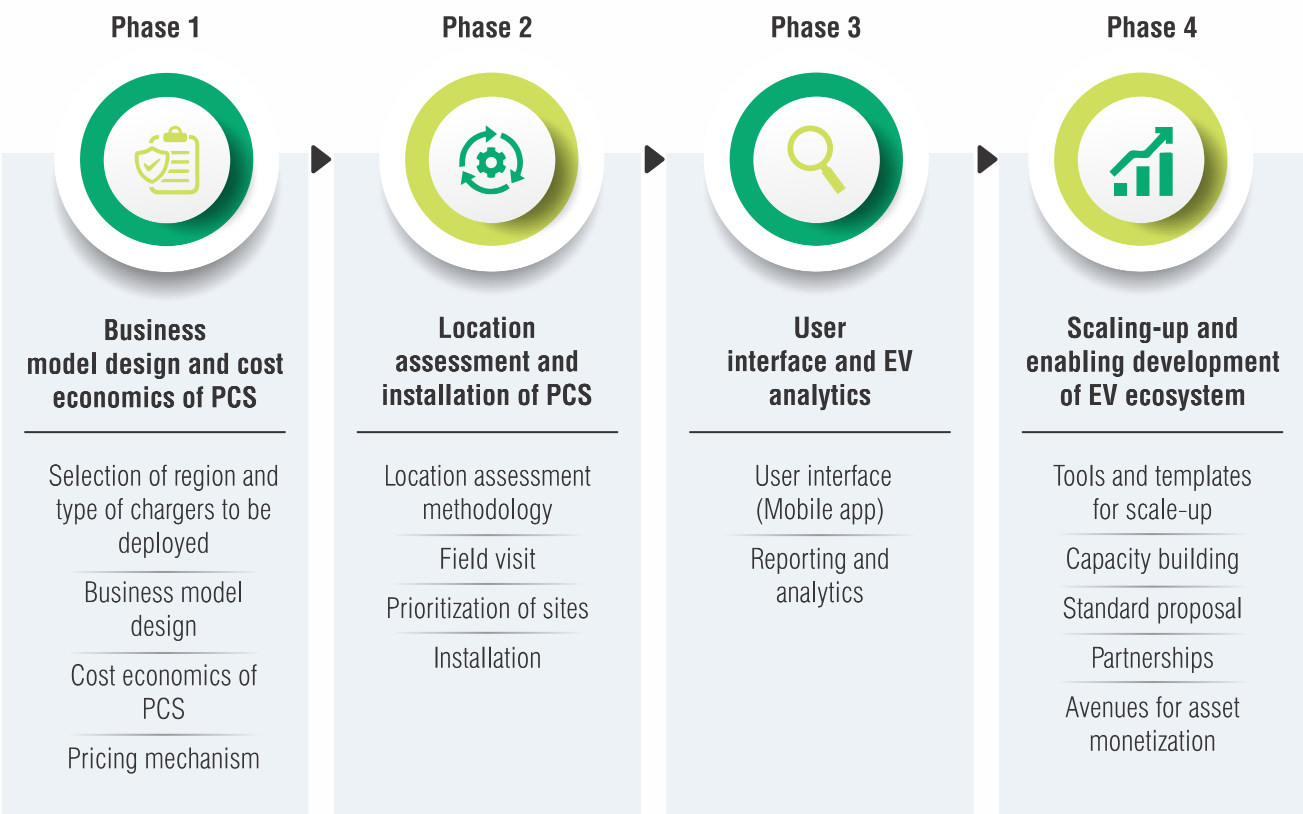
Armed with its extensive experience of installing EV chargers for captive use and with support from the USAID's SPARC Program, EESL initiated its large-scale roll-out of PCS in New Delhi. As a part of this initiative, it signed a MOU with NDMC in January 2019 to establish a sustainable business model for PCS and install upto 100 PCS in NDMC region wherein EESL has already installed more than 55 PCS. The objectives of this project include:

1. Design of sustainable business model for PCS
2. Location assessment to establish feasibility
3. Implementation support for PCS installation
4. Partnerships to ensure business sustainability and address utilization risk
5. Strategy for scale-up of PCS deployment in other cities

1.4 Project Journey

EESL's large-scale roll-out of PCS in NDMC aimed at designing and implementing a framework for large-scale roll-out of PCS in India. Several learnings emerged in the course of project execution. These learnings provides essential inputs and key considerations for PCS business. This report highlights the journey of the project from the design of business model and cost economics to implementation, operation and scale-up. Overall, the activities undertaken have been classified into four phases as depicted in Figure 4.

Figure 4: Project Phases and Activity Breakdown



Each phase, and its related activities, are elaborated in the following sections of the report.

02

BUSINESS MODEL DESIGN AND COST ECONOMICS OF PCS

2.1. Selection of Region and Type of Chargers to be Deployed

EESL selected NDMC region in New Delhi for the roll-out of the PCS project. The selection was made based on the criteria mentioned in Box 4.

Box 4: Criteria for Area Selection

Selection of New Delhi

MOP guidelines

MOP guidelines on charging infrastructure prioritizes all mega cities with a population of more than 4 million as per census 2011 for deployment of PCS [10]. New Delhi, with population of 19 million, is one of nine such cities [11].

Vehicle penetration

New Delhi has the highest number of motor vehicles registered in a single city (~8.9 million) in India [12].

EV deployment base of EESL

As a part of its National e-mobility Programme, EESL has deployed maximum number of EVs and captive chargers in New Delhi [9].

Selection of NDMC Region

High traffic and footfall

Utilization of PCS is expected to be higher in areas with higher traffic flow and footfall. Secondary assessment indicated that NDMC region is one of such area in New Delhi (details provided in Section 3.1).

Ease of co-ordination

NDMC, being both a power distribution utility and a municipal body, ensured faster and smooth implementation of project.

Complementing the Smart Cities Mission

NDMC is one of the first 20 cities selected under the Smart Cities Mission of the GOI [13]. Installation of PCS will complement the smart city program of NDMC.

Type of Chargers to be Deployed

The MOP recognizes five types of charging standards in its charging infrastructure guidelines [10], as specified in Table 1.

Table 1: Charger Types and Standards [10]

Charger connector	Power Output (kW)	Rated voltage (V)
Combined Charging System (CCS)	Min 50 kW	200-750V or higher
CHArge de Move (CHAdeMO)	Min 50 kW	200-500V or higher
Type-2 AC	Min 22 kW	380-415V
Bharat DC001	15 kW	48V or higher
Bharat AC001*	10 kW	230V

*AC001 has three connector guns, each with a power output of 3.3 kW

In order to determine the type of charger to be deployed, it was important to first understand the type of EVs available in the market. Till 2018 and early 2019, Mahindra & Mahindra[3] and TATA Motors[3] were the two major automobile companies providing four-wheeler EV passenger cars in India. EV models of both companies were compatible with Bharat AC001 and DC001 charging protocol. EESL decided to install chargers which would support fast charging for the available models. Therefore, based on the suitability of the chargers as briefed in Box 5, EESL decided to first focus on DC001 chargers.

Automobile makers such as Hyundai Motors [14] and MG Motors [15] recently launched EV models in India that are compatible with CCS charging protocol. In line with these developments and MOP guidelines, EESL plans to deploy suitable chargers (C142 chargers[4] that are compatible to the latest EV models) as a part of its scale-up program. It recently procured 200 C142 chargers for the same.

Box 5: Charger Types and Suitability

Bharat AC-001

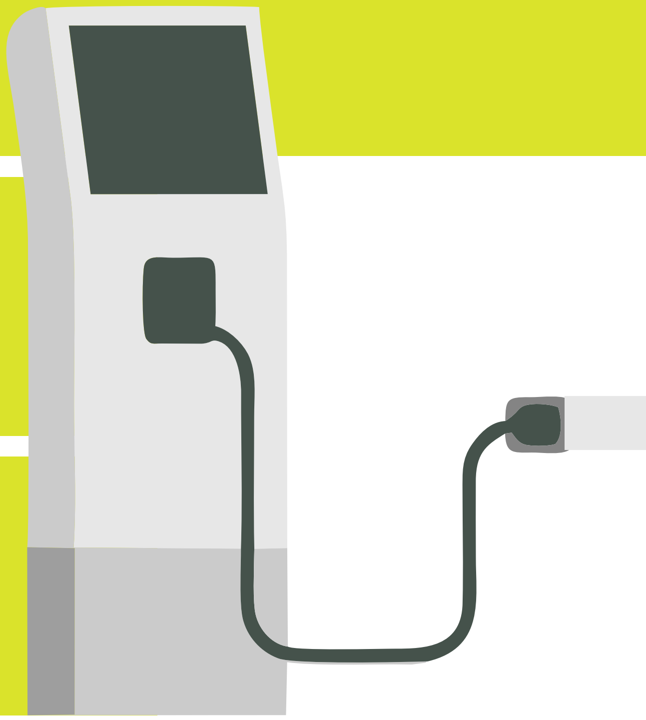
This charger type usually takes around four to five hours for charging 80% of the battery capacity (18 kWh), providing a range of 80-100 km[5]. It is suitable for long haul charging (home charging, office charging or similar), wherein the cars are parked for a long duration.

Bharat DC-001

This charger type takes around one hour for charging 80% of the battery capacity (18 kWh), providing a range of 80-100 km[5]. It is most suitable for deployment in areas which provide avenues for the EV user to spend 30 minutes to an hour till the vehicle is charged. These could be areas close to market places, shopping malls, etc.

Type 2 AC (22 kW)

This charger type takes around 1.5 hours for charging 80% of the battery capacity (40 kWh), providing a range of 180-250 km[5]. It is most suitable for deployment in areas which provide avenues for the EV user to spend 30 minutes to an hour. These could be areas close to market places, shopping malls, etc.



CCS/CHAdeMO (50 kW)

This charger type takes around 40 mins for charging 80% of the battery capacity (40 kWh), providing a range of 180-250 km[5]. It is suitable for fast charging within cities, along national highways and intercity routes.

Charging Hub

A charging hub consists of two or more chargers of different connector types in one location.

[3] EESL procured EVs from TATA Motors and Mahindra & Mahindra under a tender released in 2017

[4] A C142 charger has three connectors: (i) CCS connector with DC power output of 60 kW; (ii) CHAdeMO connector with DC power output of 60 kW; and (iii) Type 2 connector with AC power output of 22 kW.

[5] Depending on the mileage of the vehicle

2.2. Business Model Design

The primary objective of the business model was to support EESL partner with stakeholders, establish synergies and create a win-win proposition for all. A thematic structure of the business model is presented in Figure 5. The roles and responsibilities of the various stakeholders are provided in Figure 6.

Figure 5: Business Model for Installation of PCS

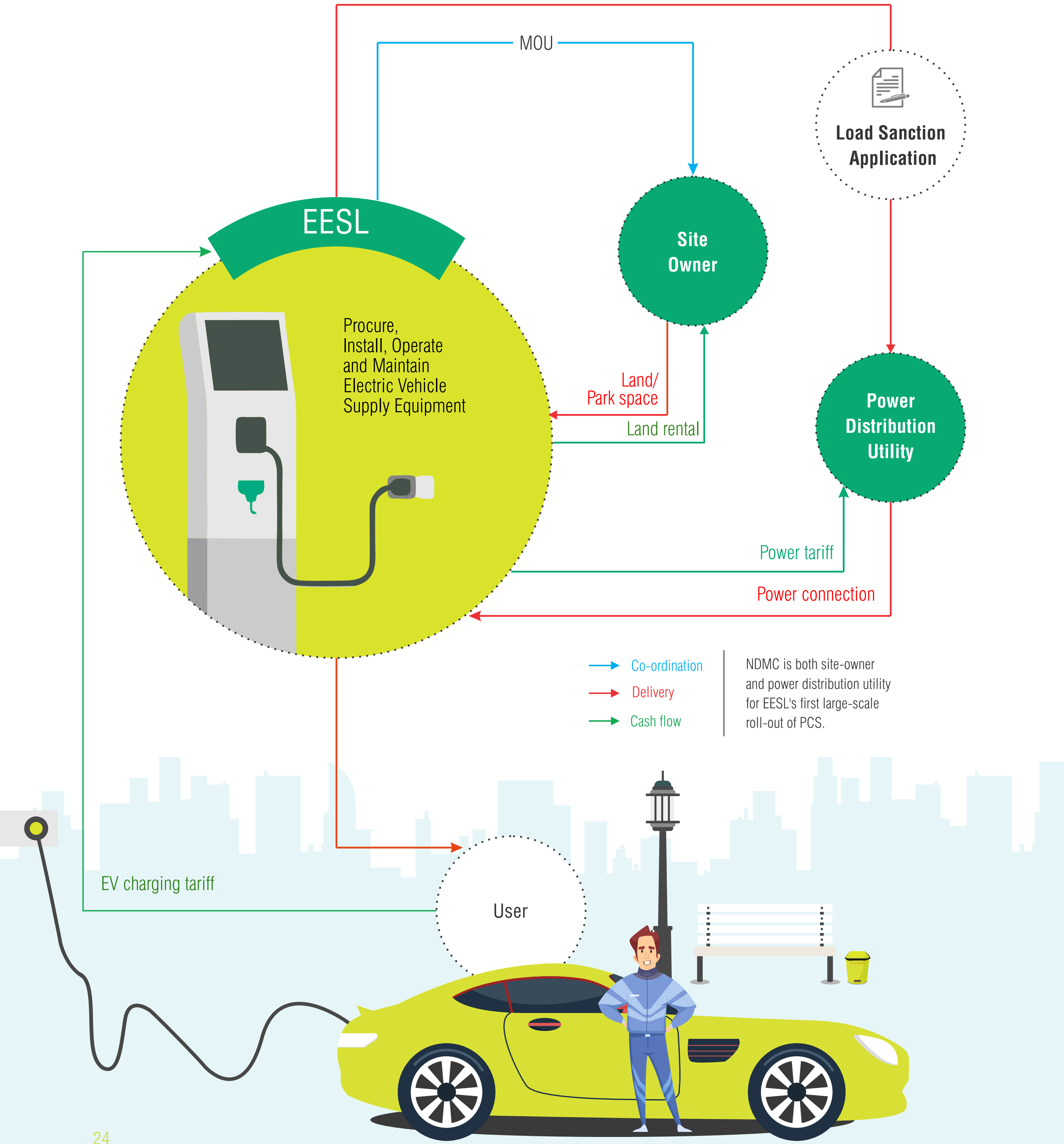


Figure 6: Roles and Responsibilities of Stakeholders

NDMC as land owner

- Provision of adequate land to install PCS
- Provision of permissions/approvals required to install the PCS, if any
- Support in coordination for sanction of power

NDMC as power distribution utility

- Provision of required electrical connectivity for PCS

EESL as charger operator

- Assessment of locations to install PCS
- Demand aggregation for PCS at the national level
- Undertake bulk procurement
- Install and operate PCS and necessary back-end systems
- Develop PCS business model with affordable tariff to general public
- Application for sanction of load
- Collection of fare from end-consumers
- Payment of land rental in lieu of land provided for PCS

The business model ensured that the PCS service is affordable for end consumers, and also benefitted all stakeholders (land owner, power distribution utility and charger operator) in several ways. Some of these benefits are mentioned in Figure 7.

Figure 7: Indicative Benefits to Stakeholders

NDMC as land owner/ municipal authority

- **Additional revenue stream:** PCS provides revenue from existing real estate assets in the form of land rental.
- **Increased EV adoption:** Several city/state governments are working towards accelerating EV adoption. Wide network of PCS will alleviate the range anxiety and encourage consumers to shift to EVs.
- **Improved local air quality:** With increasing penetration of EVs, the local emission of pollutants is expected to reduce. This will lead to cleaner air providing several health benefits to the residents.

NDMC as power distribution utility

- **Additional source of revenue:** Power utilities can realise an additional source of revenue from the sale of power through PCS.
- **Load management:** With fast paced development of automation and analytics, coupled with growth in the e-mobility sector, power utilities can also utilize PCS for load management, through time of day tariff, vehicle to grid management and related interventions.

EESL as charger operator

- **Effective implementation:** Strong partnership with land owner and power distribution utility can lead to effective implementation of the project.
- **Sustainable business:** Suitable location for PCS can lead to higher utilization and ultimately result in lower tariff for EV users.

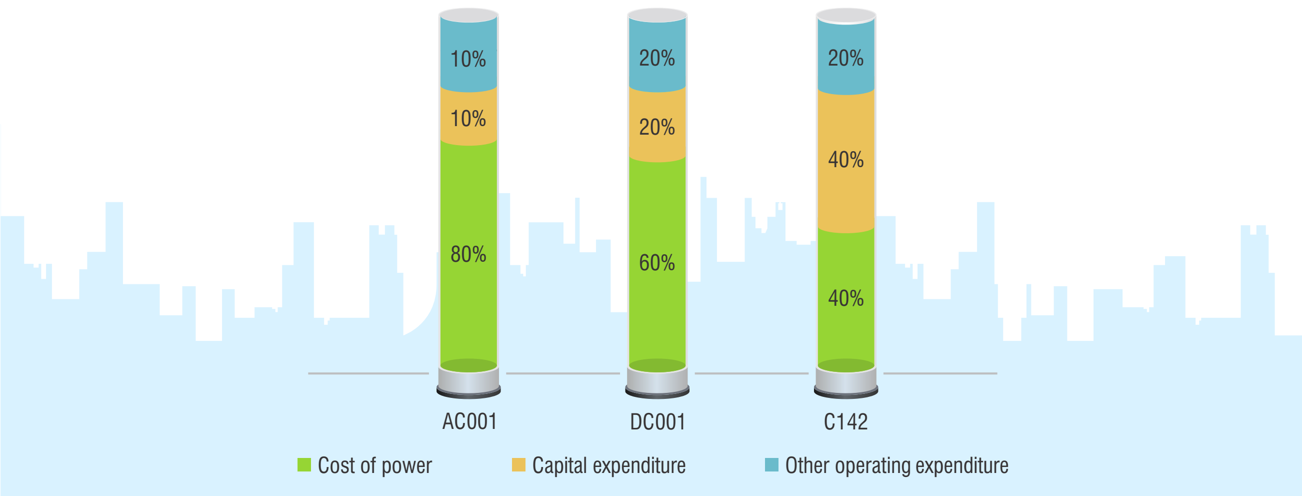
2.3.Cost Economics of PCS

The cost economics of the PCS can be broadly classified into three broad categories:

- **Cost of power:** Cost of power and applicable surcharges and duties as approved by the respective SERC and the state government.
- **Capital expenditure:** Costs related to the installation of EV Supply Equipment (EVSE) and related infrastructure such as Charger Management System (CMS), meter and meter box, and accessories such as canopy, LED screens, CCTV camera, barricading, etc.
- **Operational expenditure:** Cost of services such as payment gateway charges, parking fees, insurance premium, etc.

A detailed financial model for all type of chargers (AC001, DC001 and C142 chargers) was developed to compute the tariff to be charged from EV users for using PCS services. An indicative break-up of impact of different cost components on the PCS service fee is shown in Figure 8.

Figure 8: Impact of Different Cost Components on PCS Service Fee



Please note that the graph is indicative in nature and is scaled to 100 percent for reference.
Source: KASPL Analysis

2.3.1.Development of Financial Model

In the early stage of the project, it was believed that capital expenditure would include the cost of EVSE and the installation cost, and the operating costs would include gateway charges and annual maintenance cost. However, as EESL started installing PCS, it discovered several other costs. Table 2 provides an indicative list of cost components for deployment of PCS.

Table 2: Indicative List of Cost Components for PCS Deployment

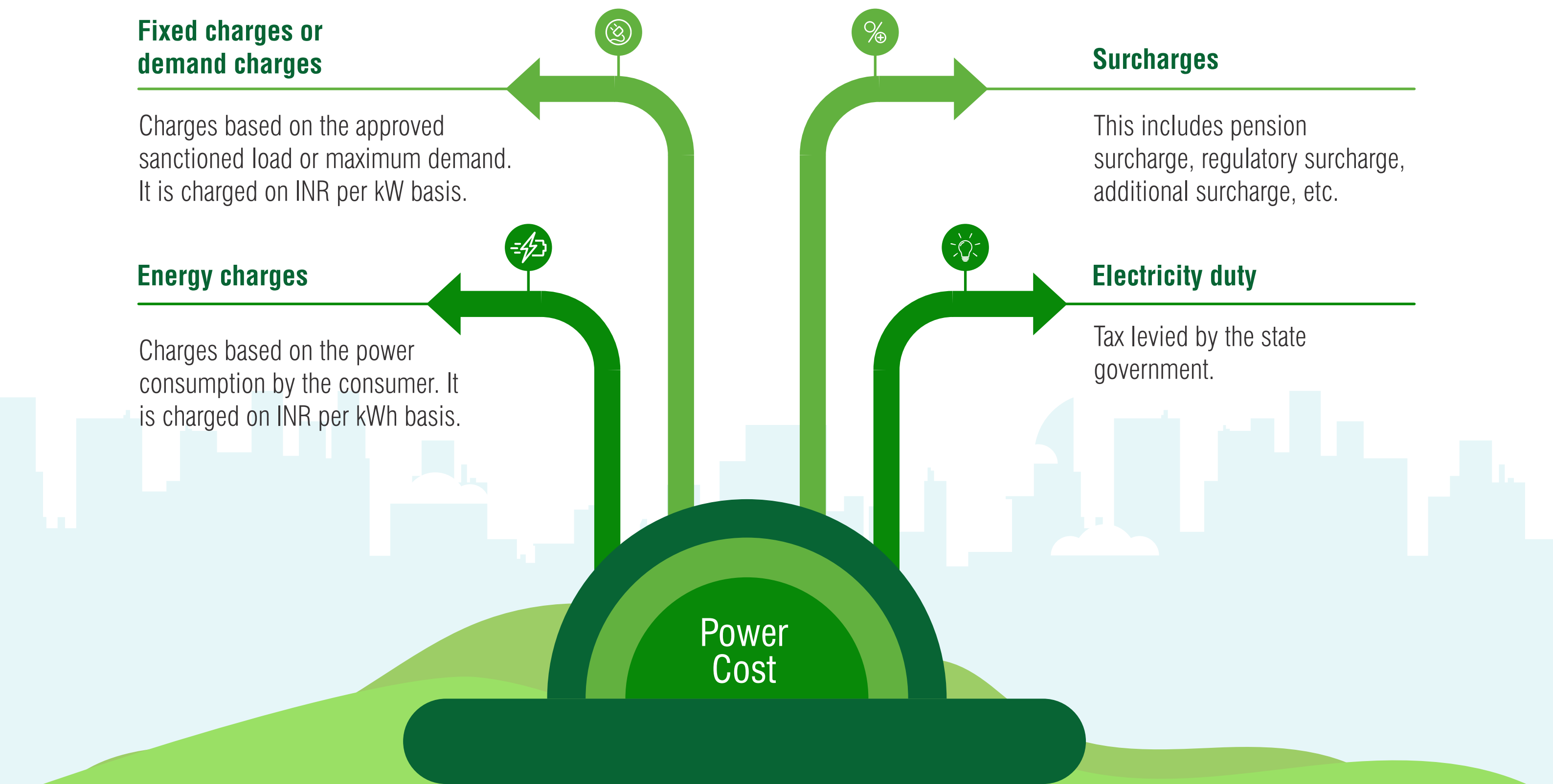
S.No.	Item
Cost of power	
1	Cost of power as approved by the SERC
2	Additional surcharges and duties as approved by the SERC
3	Cost of power losses in transforming AC power to DC power
4	Taxes/duties on cost of power as levied by state/central government

S.No.	Item
Capital expenditure	
1	EVSE unit
2	Civil works for preparing land for EV parking and installation of PCS
3	Earthing
4	Auxiliary equipment such as meter, meter box, barricades and canopy, cameras, etc.
5	Power connection costs
6	Capital cost for CMS and mobile app
7	Cost of transformers, if applicable
Operational expenditure	
1	Annual maintenance
2	Operating cost of CMS and mobile app including costs related to data connectivity of chargers with central server
3	Cost of insurance for PCS
4	Gateway charges
5	Land rental for car parking space
6	Cost of facility management services
7	Operating costs related to car parking space such as painting the surface indicating parking reserved for EVs, etc.
8	Cost of marketing and awareness, if any

Some of the core elements of costs have been detailed out in the subsequent sections.

2.3.2. Cost of Power

The cost of power payable by a consumer comprises of:



Electricity duty is approved by the state government while rest of the costs are approved by respective SERCs. A break-up of cost of power as applicable in New Delhi is provided in Table 3 while cost of power for PCS in different states of India is provided in Box 6.

Table 3: Cost of Power for EV Charging in New Delhi for FY 2019-20 [16]

Power tariff	LT connection	HT connection
Energy charges*	INR 4.5 per kWh	INR 4.0 per kWh
Fixed charges	-	-
PPAC charges**	0-5% of energy charges or INR 0-0.24 per kWh	0-5% of energy charges or INR 0-0.22 per kWh
Pension surcharge	3.8% of (Energy charges + Fixed charges - rebate) or INR 0.19 per kWh	3.8% of (Energy charges + Fixed charges - rebate) or INR 0.17 per kWh
Regulatory surcharge	8% of (Energy charges + Fixed charges - rebate) or INR 0.39 per kWh	8% of (Energy charges + Fixed charges - rebate) or INR 0.35 per kWh
Electricity Duty	5% of (Energy charges + surcharge on electricity bill + PPAC amount + TOD surcharges/rebate) or INR 0.26-0.28 per kWh	5% of (Energy charges + surcharge on electricity bill + PPAC amount + TOD surcharges/rebate) or INR 0.23-0.25 per kWh
Effective cost of power	INR 5.34-5.60 per kWh	INR 4.75-4.99 per kWh

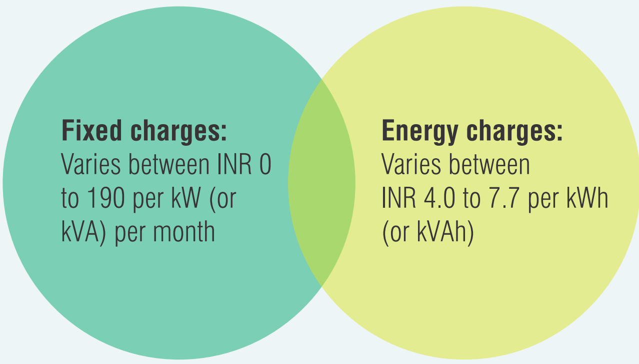
* DERC reduced the energy charges by INR 1 per kWh in FY 2019-20 from the FY 2018-19 levels

** Power Purchase Adjustment Charges (PPAC) are usually <5% of energy charges

In addition, power losses incurred in converting AC power to DC power also need to be considered while estimating the total cost of power.

Box 6: Cost of Power for EV PCS in Different States of India

Several SERCs have notified a separate tariff category for EV charging stations to promote EV deployment in their state. However, the tariff differs significantly across the states. The tariff notified by the SERCs for EV charging stations consists of:



In addition, depending on the state, additional surcharges/duties are also levied on the overall tariff which significantly impacts the landed cost of the electricity. Consequently, the running cost of EVs across states also differs.

A snapshot of tariffs in different states is provided below [17]:

State	EV Charging Tariff[6] (2018-19/2019-20)	Landed Cost (excluding fixed charges)
Andhra Pradesh	• Fixed Charges: Nil • Energy Charges for both HT and LT Connections: INR 5.00/kWh (or kVAh)	• LT and HT Connection: INR 5.06/kWh (or kVAh)
Karnataka	• Fixed Charges: INR 60/kW/month for LT and INR 190/kVA/ month for HT consumers • Energy Charges for both HT and LT Connections: INR 5.00/kWh (or kVAh)	• LT and HT Connection: INR 5.30/kWh (or kVAh)
Madhya Pradesh	• Fixed Charges: INR 100/kVA or INR 125/kW of Billing Demand • Energy Charges for both HT and LT Connections: INR 6.00/kWh (or kVAh)	• LT and HT Connection: INR 6.90/kWh (or kVAh)
Maharashtra	• Fixed Charges: INR 70/kVA/month • Energy Charges for both HT and LT Connections: INR 6.00/kWh for LT and HT connections	• LT and HT Connection: INR 7.80/kWh (or kVAh)
Delhi	• Fixed Charges: Nil • Energy Charges: For LT Connections: INR 4.50/kWh; For HT Connections: INR 4.00/kVAh	• LT Connections: INR 5.51/kWh • HT Connections: INR 4.90/kVAh
Telangana	• Fixed Charges: Nil • Energy Charges for both HT and LT Connections: INR 6.00/kWh (or kVAh)	• LT and HT Connection: INR 6.00/kWh (or kVAh)
Uttar Pradesh	• Fixed Charges: Nil • Energy Charges: For LT Connections: INR 7.70/kWh; For HT Connections: INR 7.30/kVAh	• LT Connections: INR 8.03/kWh • HT Connections: INR 7.61/kVAh

2.3.3. Capital Expenditure

It was initially believed that capital expenditure would comprise of cost of chargers, installation cost and cost of CMS. However, during implementation, several other costs were discovered and captured. This includes:

Civil works
There are two types of civil works involved in the installation of PCS:

a) Construction of ramps or removal of barriers for easier car parking.

b) Surface cutting of different types of floor such as road, marble, concrete, interlocking, etc. for power connection. Costs related to this civil works may considerably vary with the distance of power interconnection and the type of cutting required.

Auxiliary equipment
This includes expenditure towards installation of smart meters, construction of canopy, and barricades.

Power connection costs
Costs of a power connection included connection charges as approved by the SERC and associated civil works. Costs related to installation of distribution transformer will also be incurred if the distribution network needs to be augmented.

[6] Please note that the charges mentioned is for the cost of power. The EV users will need to pay PCS service fee for utilizing PCS, which includes other cost components in addition to the cost of power.

2.3.4. Operational Expenditure

In the initial stage of the project, it was believed that the operational cost would include cost of annual maintenance, operating cost of CMS, and gateway charges. However, during implementation, other operating costs were discovered and captured. This includes:

FACILITY MANAGEMENT SERVICES

Although the PCS are unmanned, facility management services for timely cleaning of the chargers is required.

INSURANCE

Insurance against theft, damages, accidents, etc.

PAINTING THE SURFACE

The car parking surface needs to be painted indicating that the space is reserved for EVs only. This may have to be repeated several times over the lifetime of the chargers.

LAND RENTAL

One of the major requirements for PCS deployment is land for parking EV. As a result, land rental is a significant factor in determining tariff for PCS service. Land rental could be in two forms: a) fixed monthly/annual rental, and b) variable rental in the form of revenue sharing.

Box 7: Impact of Fixed Rental on the End-consumer Tariff

The impact of fixed rental or cost for land on the end-consumer tariff depends on the type of chargers. The impact would be higher on slow chargers since delivering the same amount of energy takes longer time on a slow charger. For instance, the AC001 charger usually takes four-five hours to charge an EV. So, charging a fixed land rental, for instance INR 20 per hour per car, would lead to INR 80-100 for a full charging session while the impact for a DC001 charger would be limited to INR 20 considering its takes around one hour for full charge.

As explained in Box 7, fixed rental can have significant impact on the PCS service fee depending on the type of chargers. Hence, for this project, a rental in the form of revenue sharing was designed in a manner which benefitted both stakeholders: EESL and NDMC (as land owner). The rental amount adequately compensated the land owner while ensuring an affordable PCS tariff to the end consumer. The land rental considered the loss in revenue to the land owner, which was in the form of parking fees lost on account of space reserved for EV and EV charger. The loss was compensated by rental revenue from PCS on energy basis. In other words, the land rental amount was determined by linking the utilization/electricity consumption of the chargers (on INR per kWh basis), instead of a fixed amount. The overall premise to compute the same is mentioned in Figure 9.

Figure 9: Basis for Calculation of Energy-based Land Rental

Loss in revenue = **Rental revenue from PCS**

Space reserved for EV and PCS | Different charger types and their estimated use

Estimating total loss in revenue

Assumptions

- Parking fees @ INR per hour per car with/without annual escalation
- Percentage of "paid" parking spots
- Utilization of parking spot
- Total number of years considered

Total loss in revenue : Parking fees x (Total number of sites x % paid parking) x parking time utilized x 365 x total number of years

=

Estimating expected rental revenue

Assumptions

Charger type	Land rental	Time taken to charge 80% battery capacity	Effective land rental	Utilization	
				Base year	Annual Escalation
DC001/ Type II AC/ DC50	INR per kWh	Hours	INR per hour	%	%

Revenue from each charger type = Effective rate (per hour) x charger utilization x 24 x 365 x total number of years

Revenue from PCS: Σ Revenue from each charger

2.3.5. Impact on the PCS Service Fee with EESL as Charger Operator

EESL's role as a charger operator helped in lowering the PCS service fee.

Demand aggregation: EESL has extensive experience in demand aggregation. Some of these experiences are briefed in Box 8. The typical capital investment required for AC001 chargers is INR 70,000-80,000, DC001 chargers is INR 4.5-5 lakhs and high capacity charger (C142 charger) is around INR 22-25 lakhs [18][7]. EESL, with its demand aggregation and bulk procurement model, was able to reduce these costs by 15-20%.

Low cost financing: EESL has access to lines of credit from various multilateral banks such the Asian Development Bank, the World Bank, etc. leading to lower cost of financing.

Other synergies: EESL was able to explore synergies with its other programs to reduce the end-consumer tariff for PCS. For instance, EESL has several ongoing energy efficiency programs due to which it has established strong professional relationship with different stakeholders including municipalities, power utilities, vendors, payment gateway service providers, etc.

[7] Please note that these costs include all capital cost components explained earlier excluding the cost of transformer

Box 8: EESL's Experience in Undertaking Demand Aggregation and Bulk Procurement

EESL has extensive experience in demand aggregation business models. It has successfully implemented large-scale programs such as the Unnat Jyoti by Affordable LEDs for All (UJALA) scheme wherein over 34 crore LED bulbs have been distributed across the country. This model has been effective in reducing the prices of LEDs significantly in the country. EESL has also undertaken other large-scale deployment such as street lights, super-efficient ACs, solar PV pump, etc.

2.3.6.Impact of Utilization on End-consumer Tariff

Utilization of PCS is a local aspect and depends on the nature and type of PCS usage in a country. Factors which may impact utilization of PCS include penetration of EVs in the market, average number of EVs per PCS, typical duration of trip by EV users (long/short trips), etc. Key aspects related to utilization of EV chargers across the globe is depicted in Box 9. Ensuring high utilization of PCS is essential for viability of a PCS business. Further, utilization levels significantly impact the PCS service fee.

Box 9: Utilization of PCS Globally

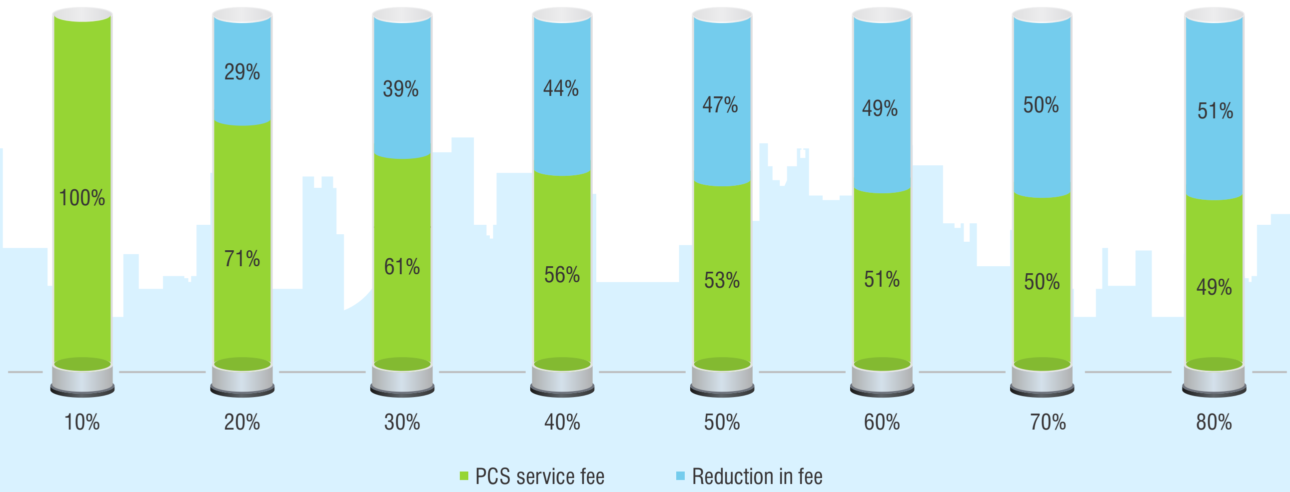
Considering that the EV ecosystem is still in its nascent stages across the globe, the ratio of EVs per public charger (both slow and fast) is still evolving. For instance, in 2018, there were 9.5 EVs per charger as against 7.3 EVs in 2017 and 6.0 EVs in 2016 [2].

Several studies have been conducted to understand the utilization of chargers across the globe. Some of the key findings include:

- Most of the charging sessions (more than 70%) take place at home or workplaces with rest of the charging done at public charging stations [19].
- EV users usually prefer to take a "top-up" from PCS which can be provided in a short duration at fast charging stations.
- People value time and are ready to pay a premium for fast charging service [20].

Figure 10 provides the sensitivity of PCS service fee with varying utilization keeping everything else constant.

Figure 10: Sensitivity of PCS Service Fee with Utilization



Please note that the graph is indicative in nature for DC001 chargers and is scaled to 100 for reference.
Source: KASPL Analysis

As evident from Figure 10, utilization significantly impacts the overall business viability of PCS. Therefore, a detailed location assessment for selection of sites (where minimal capital investment and higher utilization is expected) is a pre-requisite for installation of PCS.

2.4. Pricing Mechanism

There are different mechanisms for charging PCS service fee to EV users. To understand these mechanisms, a study of eight countries (Australia, Canada, Hongkong, Malaysia, Norway, Sweden, U.K. and U.S.) was undertaken. The study identified the following three most prevalent pricing/charging mechanisms:

Time-based fee

EV owner is charged for the total time his/her vehicle is connected to the charge unit, irrespective of the energy consumed.

Energy-based fee

EV owner is charged based on the total electricity consumed.

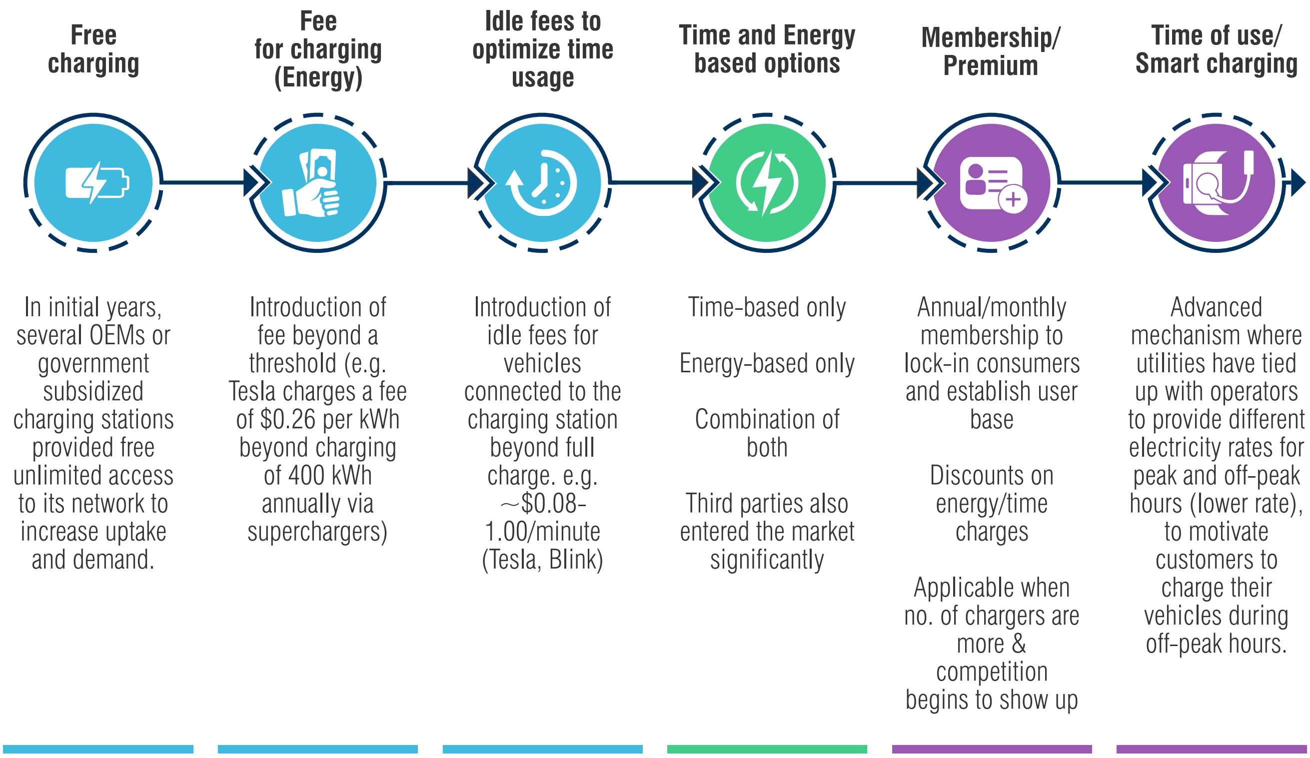
Fixed fee

EV owner is charged at a flat fee, irrespective of the time the charging station is used, or the energy consumed during charging.

Internationally, these pricing mechanisms have evolved over time. They started with free charging introduced by OEMs and/or government departments/state-run agencies to increase uptake and create demand for EVs. It then graduated to introduction of a nominal fee (mostly energy) for charging, followed by introduction of idle fees for usage beyond the charging limit– indicating time-based charging as a preferable option.

In some markets, operators provide membership to their charging network for premium access and discounts. Some utilities have also tied up with operators to provide advance pricing mechanisms such as time-of-use (different electricity rates for peak and off-peak hours), smart charging, etc. The evolution of pricing mechanism is further explained in Figure 11.

Figure 11: Evolution of Pricing Mechanism



Source: KASPL analysis supported through study of charger operators globally. Sources of charges: [21] [22]

Over time, it was observed that time-based charging started having wider usage and acceptability, particularly on account of the following reasons:

- Ease in understanding for the customers as compared to energy-based charging
- Builds transparency and trust among consumers (hence supports uptake)
- Permits verification

The time-based charging was also widely accepted by charger operators as it nudges the consumers to move out of charging infrastructure once their vehicle is charged. This also leads to increased availability of infrastructure to EV owners. However, to keep it simple, EESL adopted the energy-based pricing mechanism. Once the market matures and demand for PCS increases, other mechanisms such as membership/premium or time-of-use can be adopted.

03

LOCATION ASSESSMENT AND INSTALLATION OF PCS

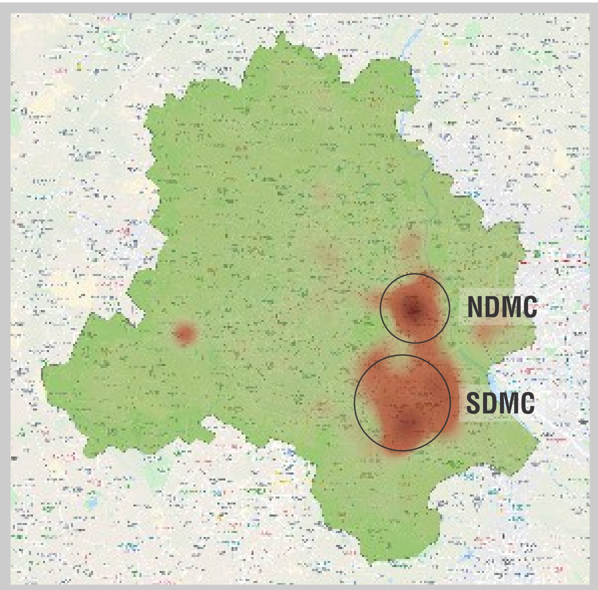
Detailed location assessment includes primary and secondary assessment, which is essential to ensure sustainability of PCS business.

SECONDARY ASSESSMENT	To identify high footfall areas.
PRIMARY ASSESSMENT	To understand site specific conditions.

3.1. Secondary Assessment

Areas with high footfall is where EV users are also expected to visit the most. To assess the footfall, concentration of Points of Interest (POIs) such as transportation hubs, places of worship, and other public spots such as malls, restaurants, hospitals, etc. was measured for Delhi and areas with high concentration of POIs were prioritized. The heat map of concentration of POIs is as depicted in Figure 12.

Figure 12: Heat Map Showing Concentration of POIs on the Map of Delhi



Low — High

Concentration of POIs

NDMC region covers prime areas in New Delhi like Connaught Place, Janpath, Rashtrapati Bhawan, Lodhi Garden, Khan Market, Nehru Park, Sarojini Nagar, Channakyapuri, Netaji Nagar, Rashtrapati Bhawan, India Gate, Embassy of various countries, etc.

As seen in Figure 12, maximum concentration of POIs fall under two municipalities: SDMC and NDMC. For Phase 1, EESL selected NDMC region for installing its PCS network (refer section 2.1.1). Subsequently, EESL signed a MOU with NDMC for installing PCS. Initially, EESL aims to install PCS at registered parking locations of NDMC for reasons as explained in Box 10.

Box 10: Selection of Registered Parking Sites for PCS Deployment

Re-fueling or charging behavior of an ICE vehicle is significantly different from that of an EV vehicle. While an ICE vehicle can get a range of 500 km within 5-10 minutes of re-fueling, an EV takes more than 30 minutes for a range of about 100 km (depending on the type of charger and type of battery in EV). Hence, while charging or re-fuelling an EV, the user will need avenues to spend more than 30 minutes of free time. The registered parking sites of NDMC are near such avenues, i.e., parking sites of NDMC are close to market places, shopping malls, offices, etc. Hence, the parking sites of NDMC were selected for deployment of PCS. Further, all these parking sites are already known to public and people use them during the normal course of the day. Therefore, utilizing chargers installed in these sites may fit well within the normal routine of EV user.

3.2. Primary Assessment

Discussions were held with NDMC officials for understanding the electrical network profile of NDMC. Some of the key aspects discussed includes:

ELECTRICAL NETWORK IN NDMC REGION

Electrical network in major parts of NDMC area is underground, especially in Connaught Place. In the inner circle and middle circle of Connaught Place, power load of more than 20 kW is not readily available since all conduits for power lines are completely full.

Further, most of the VVIP areas in NDMC have dedicated power network (substation and distribution transformer). Hence, in these areas, power network may not be available for PCS. For instance, there is no network available in the parking lot of the Rail Museum since lines are dedicatedly laid for Rail Museum. To obtain power load in these regions, significant augmentation in distribution network could be required.

CIVIL WORKS

In certain areas, it was observed that civil works may not be possible due to various reasons. For instance, in one of the sites, the nearest source of power connection was available across the road. However, the road is one of the busiest roads in the city, wherein the traffic cannot be obstructed. To secure power connection from the second nearest interconnection, considerable civil works would be required, thereby increasing capital expenditure.

It was observed that availability of power network assumes a central role in the deployment of PCS. Certain locations may seem to be ideal for PCS, however due to unavailability of power load or difficult civil works, installation of PCS at those sites may become unviable. Therefore, it was important to do location assessment jointly with the power distribution utility.

In this context, EESL officials, along with NDMC representatives, undertook a survey to understand the feasibility of locations. A detailed questionnaire was prepared for the same. The parameters considered for physical site survey are mentioned in Table 4.

Table 4: Parameters Considered for Physical Site Survey

SN	Parameter	Description	Method of recording (Illustrative)
1	Parking space	Availability of enough parking space in and around the site	• Space for 2W, 3W, 4W, Buses • Space for multiple chargers/charging hub • Paid/unpaid parking • On-road/off-road parking

SN	Parameter	Description	Method of recording (Illustrative)
2	Ease of parking	• Passage for entry and exit for the vehicles in the parking space	• Easy/moderate/difficult • Obstructions (if any)
3	Load availability	• Load (kW) that can be easily provided by the power distribution utility at the site • Assessment of total number of chargers and type of chargers that can be installed in a single location	<50kW — 50-100kW — >100 kW • Reasons in case of no load is available
4	Distance from the nearest source of power connection	• Distance from the nearest transformer, feeder pillar, or substation to the site to ensure faster sanctioning of connection • Estimation of the cabling and other civil works required	• Distance from nearest interconnection <50m — 50-100m — >100m • Cabling estimation
5	Civil works required	• Civil works required for installation of the charger, including wiring, cabling and preparing site for EVs, including site levelling, if required	Surface cutting required Interlocking: ✓ / Road: ✓ / Concrete: × / Marble: ×
6	Visibility and footfall	• Visibility of the site for the public (moving traffic and pedestrians) and footfall around the site (presence of market, shopping malls, commercial places, etc. in the vicinity)	Low — Medium — High

Additional parameters/factors specific to the region were observed and recorded during the location assessment. For instance, at some sites, consent from nearby Resident Welfare Associations (RWAs) and/or market associations was required. At one site, taxi stand was required to be relocated for deploying PCS, at another site, an under-pass was expected to be constructed in near future which could lead to changes in layout of power network. All these parameters were recorded and considered for final site evaluation.

3.3. Field Visit

The joint survey team of EESL and NDMC officials visited around 150 parking sites of NDMC and recorded details as per the questionnaire.

Figure 13: Field Visit by Joint Survey Team in NDMC

3.4. Prioritization of Sites

The sites were categorized as Priority 1, 2 and 3 based on the primary survey. The criteria for site prioritization included:

a. Priority 1

Sites where charger installation required minimum cost and interventions.

The parking sites categorized under this priority were sites where power connection was readily available with easier access to parking, with high visibility and high-medium footfall.

b. Priority 2

Sites where charger installation required minor interventions.

The parking sites categorized under this priority were sites which were either medium in visibility or where other site(s), surrounding that site were already selected in Priority 1 list.

c. Priority 3

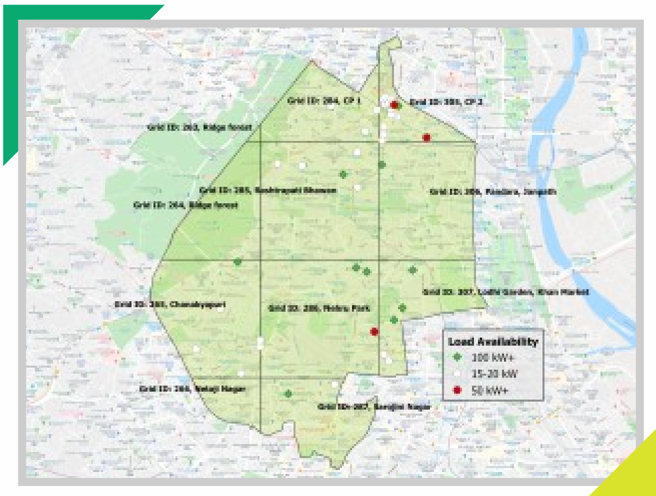
Sites where charger installation was difficult or sites which required major interventions for installation of chargers.

The parking sites categorized under this priority were sites which had poor visibility or congested parking or power connection not available or where a lot of civil works was required to provide the power connection.

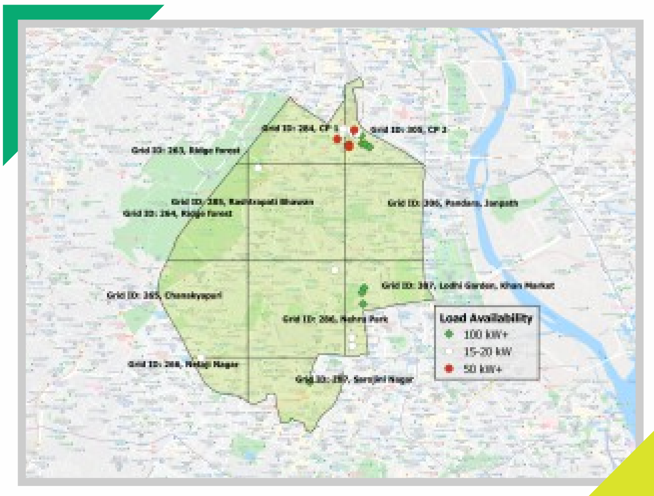
Priority 1 and 2 sites identified are depicted in Figure 14.

Figure 14: Prioritization of Sites in NDMC Region

Priority 1 Sites



Priority 2 Sites

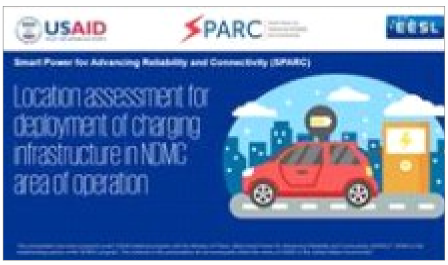


Map is for graphical indicative/depiction purposes only. It does not represent a legal boundary.
The name to each grid-block is given based on the post popular and recognizable spot within the grid-block.

A snapshot of the analysis is provided in Figure 15.

Figure 15: Snapshot of the Analysis Prepared for PCS Installation in NDMC

Grid ID	Area	Load availability in sites (kW)		
		<25	~50	>100
287	Sarojini Nagar Market	1		2
266	Netaji Nagar	1		
284	CP	6	1	
305	CP	22	6	5
307	Lodhi Garden, Khan Market	4		7
286	Nehru park		1	2
265	Chankyapuri	2		1
306	Pandara, Janpath			1
285	Rashtarpati Bhawan	4		
Total		40	8	18



Box 11: Key Learnings from Location Assessment

In few sites, enough load is not available in existing feeders/transformers for supply of power to PCS. Augmentation or installation of new feeders/transformers may be required to provide the required load for PCS. In such cases, the overall cost for installation and operation of PCS is expected to increase significantly, resulting in increase in PCS service fee.	In some sites, civil works such as construction of ramps, etc. may be required to ensure easy accessibility of PCS to EV users. This may lead to significant increase in investment required to establish charging stations.	Some sites are favourable for installation of a single charger, while some sites are favourable for installation of more than one charger (charging hub). Combination of both complements the development of PCS ecosystem.	In addition to availability of power, availability of land is a key parameter for installation of PCS. State governments need to facilitate the land for installation of PCS for cohesive development of PCS network.

Central/State government needs to bring in provisions to ensure that parking space reserved for EVs, specially EV charging, is not blocked by ICE vehicles. One such initiative was taken by the Government of Ontario (Canada), which passed a bill in December 2019 levying a fine of about USD 95 for ICE vehicles parked on the spot reserved only for EVs [23] .

3.5. Installation

EESL undertook installations after all the sites were finalized. The project was inaugurated in April 2019. As of December 2019, more than 55 PCS were installed in New Delhi. Figure 16 showcases NDMC region categorized in a grid of 3x3 km and location of PCS installed.

Figure 16: Location of PCS Installed in the NDMC Region

55

Public Charging Stations installed

As on Dec 2019

Map is for graphical indicative/depiction purposes only. It does not represent a legal boundary.

The name to each grid-block is given based on the post popular and recognizable spot within the grid-block.

Launch of the Project

PCS installed
in Khan Market,
New Delhi

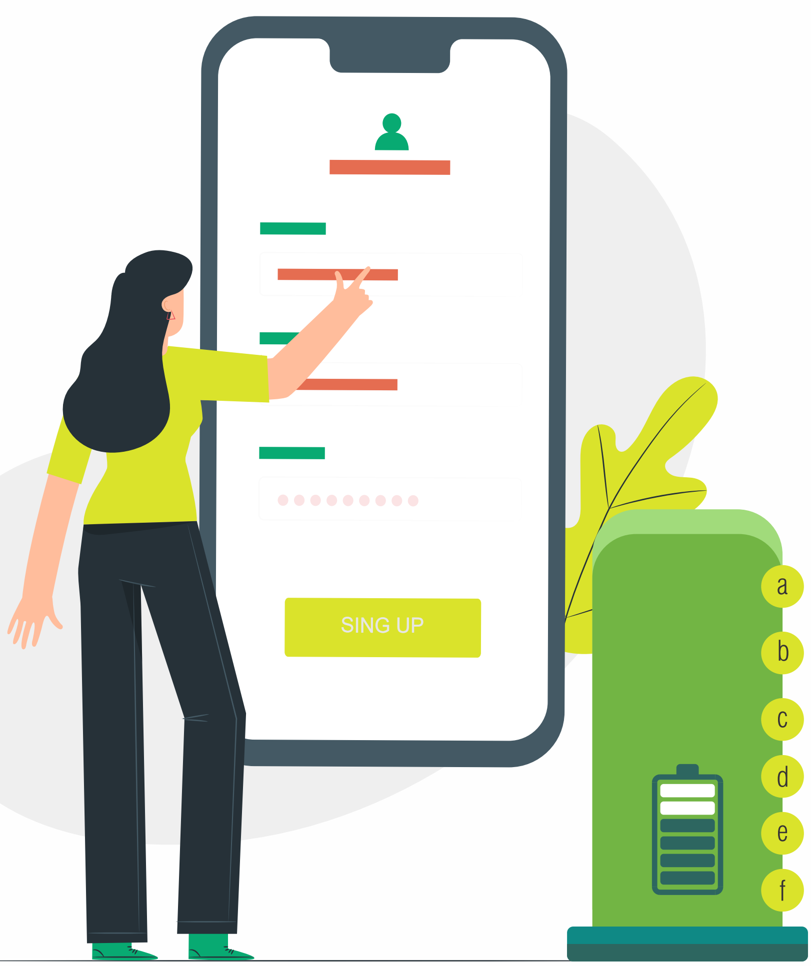
04

USER INTERFACE AND EV ANALYTICS

All charging stations are envisaged to be unmanned stations - operated through a mobile app developed specifically for this purpose. A dashboard for monitoring the utilization of chargers and analyzing key performance indicators was developed.

4.1. Mobile Application for EV users

A digital platform to book chargers and pay for charging services is essential for convenience of the consumers as briefed in Box 12. Some of the key features of the mobile application used by EESL to book the chargers is provided below.



Key features:

- a. Unique profile for EV users
- b. Location of nearby charging stations and ability to filter the same by availability and charger plug
- c. Online booking for the charging station for a specific time slot
- d. Historical charging details
- e. Integration of all available modes of payment
- f. Customer care details for any assistance

Box 12: Digital Platform for Charging Services

Currently, there are limited charger operators in India. As more consumers join the EV bandwagon and new charger operators enter the market, it is expected that the number of mobile apps offering PCS services would also increase. Customers would need to register on different apps offered by different charger operators to be able to use all the available PCS. A single platform for all chargers will therefore be essential for customer convenience in the future. In Norway, NOBIL, an open and publicly-owned database of EV chargers, was developed by governmental entity Enova and the Norwegian Electric Vehicle Association. NOBIL is a publicly-owned database that allows everyone to build services using standardized data free of charge [24].

A single digital platform for all chargers will be required for consumer convenience in the future.

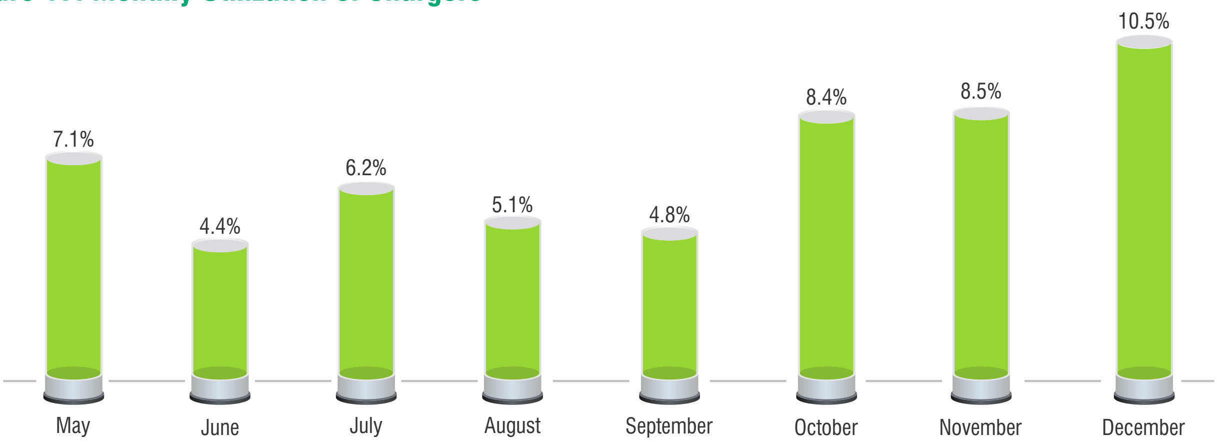
4.2. Reporting and Analytics

Capturing data for reporting and analytics is not only important from the perspective of monitoring the utilization of chargers but also to capture useful insights such as State of Charge (SOC), total energy consumed, etc. Accordingly, "ChargeD", a Charger Monitoring Dashboard, was developed to draw out key insights from the PCS installed.

Some of the initial trends on utilization of PCS during May-December 2019 include:

a) Overall utilization of PCS has shown an improving trend over the months, with utilization of around 10.5% in December 2019 (refer Figure 17).

Figure 17: Monthly Utilization of Chargers

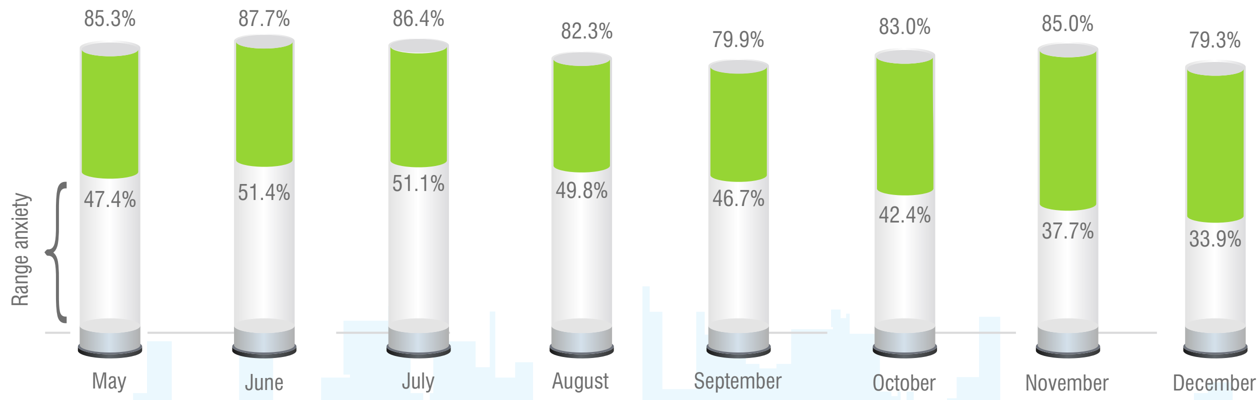


b) As of date, less than 1% of the total charging is done by general public, which reflects on the overall penetration of EVs in Delhi for personal use.

c) Range anxiety, reflected through initial SOC of EVs, has reduced to 33 km[8] in December 2019 from around 53 km in May 2019, reflecting increased confidence on EV infrastructure (refer Figure 18).

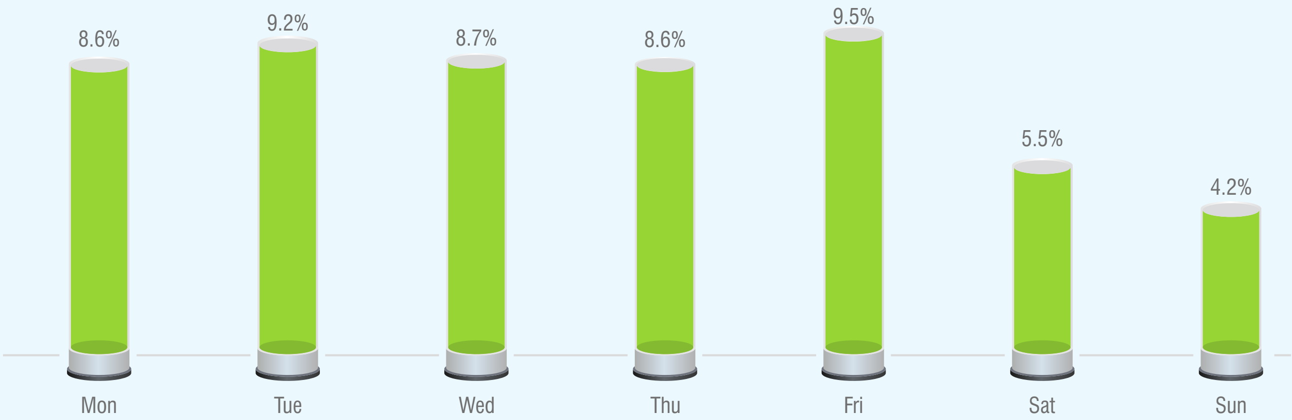
[8] Assuming a mileage of 6 km per kWh and EV with battery capacity of 18 kWh (Based on models available in the market and vehicles compatible with DC001 chargers)

Figure 18: Range of SOC at PCS



d) It is observed that chargers are utilized the most during the weekdays. This may be because most EVs currently using the chargers are either commercial vehicles or EESL-owned/leased vehicles, which are mostly utilized during the working days as depicted in Figure 19.

Figure 19: Utilization of Chargers over Weekdays



While these are initial trends, they provide significant insights to different stakeholders. A charger operator can use this data for planning its PCS deployment initiative. Similarly, a power distribution utility can use this data for load management, introduction of new time-of-day tariff for shifting the peak load demand, etc. The use of EV analytics dashboard is multiple and the benefits to stakeholders are immense. As the sector evolves, the requirement for a consolidated dashboard to monitor PCS will become essential to ensure cohesive development of electric mobility and related sectors.

[8] Assuming a mileage of 6 km per kWh and EV with battery capacity of 18 kWh (Based on models available in the market and vehicles compatible with DC001 chargers)

05

SCALING-UP AND DEVELOPMENT OF EV ECOSYSTEM

EESL plans to install more than 1,500 PCS across India by 31 March 2021. Standardized templates, location assessment, capacity building of regional officers, partnerships with various EV ecosystem players, and identification of avenues for asset monetization (non-fare revenue) helped EESL not only in the initial PCS installations but also in setting its scale-up strategy.

5.1. Templates and Framework for Scale-up

All templates and frameworks used in installation of PCS in New Delhi were standardized for use in the scale-up phase.

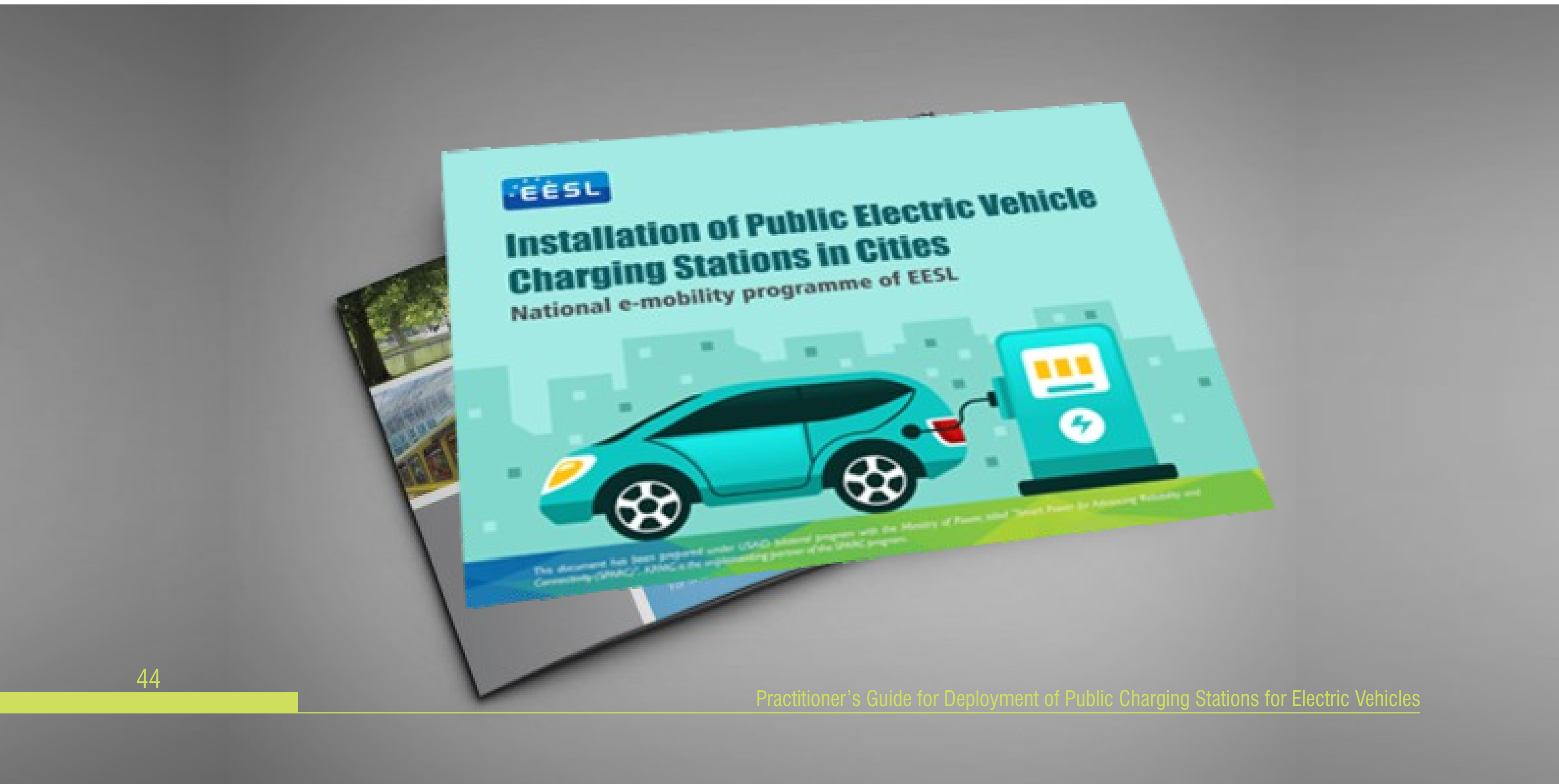
List of Standardized Documents

- ☑ Brochure for EESL value proposition
- ☑ Checklist for installation of PCS
- ☑ Location Assessment Methodology
- ☑ MOU/Agreement Template

Standard Offer for Installation of PCS

A standard offer document (brochure as depicted in Figure 20) providing EESL's value proposition for installation of PCS in order to reach out to various cities administration for partnership and collaboration.

Figure 20: Snapshot of the Brochure providing EESL's Service Offering for PCS



Standard Checklist for Installation of PCS

A standard checklist for effective preparation of scale-up strategy for installation of PCS across cities is provided in Table 5.

Table 5: Checklist Highlighting the Requirements for Installation of PCS

S. No.	Parameter
✓	**Approach and Design**
1	Signing of MOU with city administration
2	Plotting points of interest on city grid map for secondary assessment
3	Business model for installation of chargers
4	Preparing a financial model
5	Identifying sources of funding
✓	**Location assessment**
6	Formation of joint survey team
7	Site survey and feasibility assessment
8	Prioritization of locations
✓	**Implementation and installation of chargers**
9	Signing of Agreement with city administration
10	Procurement of chargers
11	Installation of chargers
12	Sanction of load/power connection
13	Identification of issues related to installation and resolution of the same
✓	**Operation and maintenance**
14	Standard Operating Procedure for use of chargers
15	Pricing strategy, including fare and non-fare revenue
16	Integration of payment gateway
17	Mobile app for booking charger
18	Integrated dashboard for monitoring

Standard Location Assessment Methodology

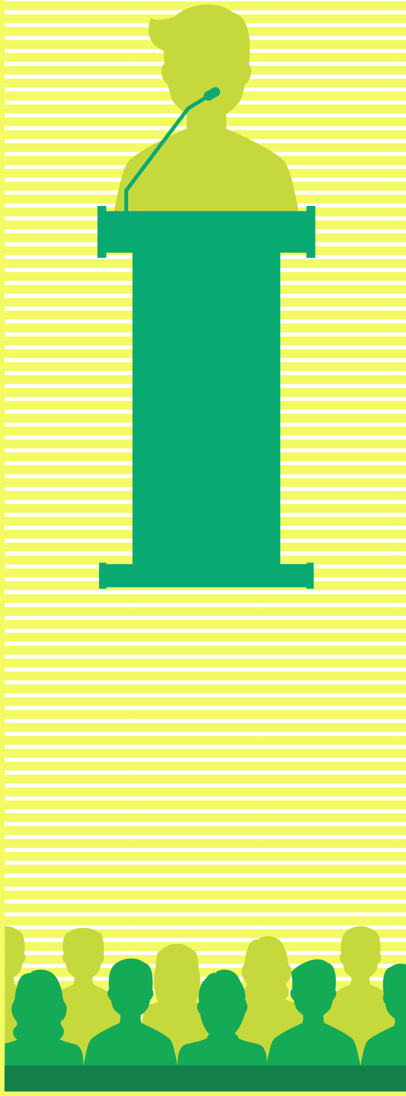
A standard location assessment methodology for carrying out site assessment across different cities.

Standard Agreement Template

Standard MOU and agreement templates for partnering with municipalities, metro operators, fleet operators, OEMs, and other stakeholders.

5.2. Capacity Building

To support EESL in scaling the project across other locations, it was important to train its officials from regional offices on the entire life-cycle of the PCS project. In this context, capacity building program was undertaken on the following aspects:



1 Critical aspects for deployment of PCS

EESL managers from regional offices were provided with reference materials and documents which covered all the critical aspects required for deployment of PCS. The managers were provided an overview of the project's journey in Delhi, and apprised of the business model, cost-economics, framework for location assessment, etc. They were also apprised of key challenges faced during the project journey, and of potential mechanisms to address the same while scaling up the installation of PCS in their respective regions.

2 Location assessment

Officers from EESL regional offices were invited for a hands-on experience of conducting surveys for assessing the feasibility for setting up of a PCS. The officers representing EESL offices from Andhra Pradesh, Telangana, Goa, Kerala, Karnataka and Tamil Nadu were present for the survey conducted in Chennai. Similarly, EESL officers from the Delhi office were present for the survey conducted in NDMC, SDMC, Gurgaon and Noida.

The survey methodology was explained to the officers in advance. During the survey, various queries and doubts raised by the EESL officers were resolved. The officers accompanying the field survey were also acquainted with the standardized survey format.

This exercise enabled regional EESL officials to conduct primary surveys in their respective states/locations for EV PCS deployment. Post this exercise, EESL undertook site assessment on its own in cities such as Kolkata, Bengaluru, Mumbai, Ahmedabad, etc.

5.3 Partnerships

Establishing partnership with stakeholders supports collaborative growth and facilitates an enabling ecosystem for EVs. EESL's success in forging partnerships with several stakeholders helped it on several fronts. For instance, creating awareness on EVs and enhancing the utilization of chargers, thereby making the PCS business more sustainable.

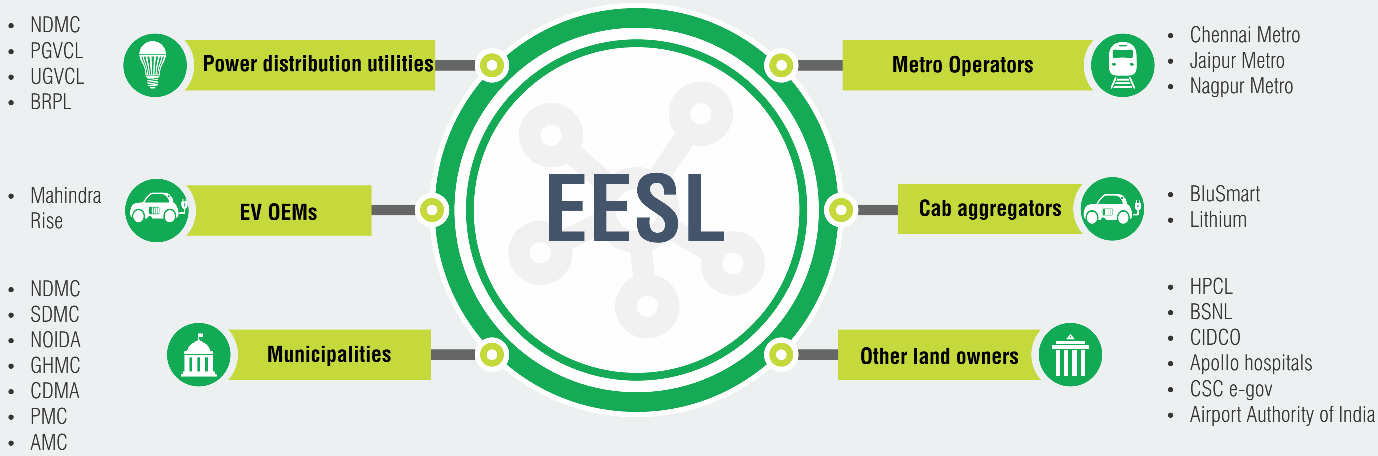
EESL's success in forging partnerships with several stakeholders helped it on several fronts. For instance, creating awareness on EVs and enhancing the utilization of chargers thereby making the PCS business more sustainable.

The stakeholders involved in the EV ecosystem include (but are not limited to): charger operator, power utilities, EV OEMs, cab aggregators/fleet operators, city administrators/local municipalities/other land owners, etc. Some of the important considerations to establish partnership with stakeholders include:

- **Land owners:** Land owners provide space for installation of PCS in lieu of a fee. The fee for land could be in the form of fixed rent, revenue share or any other form.
- **Power utilities:** Power utilities provide power connection and supply power for operating the PCS. Power utilities can benefit from PCS not only as an additional source of revenue, but also for load management.
- **EV OEMs:** A wide network of PCS reduces the range anxiety and thereby helps EV OEMs increase sales of their EVs without significant investment in charging infrastructure. Partnering with EV OEMs at the same time can help improve the visibility of PCS and ensure utilization of PCS.
- **Cab aggregators/fleet operators:** Cab aggregators are increasingly including EVs in their fleet of vehicles. With PCS already installed, cab aggregators will not have to invest in charging infrastructure. Partnering with cab aggregators can help improve EV uptake and increase utilization of PCS.
- **Metro operators:** EVs and metros complement each other's growth. EVs promote clean transportation and metros promote clean public transport. EESL has tied up with the metro operators for installation of PCS to ensure electric last mile connectivity.

A snapshot of EESL's partners in India is presented in Figure 21.

Figure 21: EESL's Partners in Installation of PCS



NOIDA: New Okhla Industrial Development Authority; GHMC: Greater Hyderabad Municipal Corporation; CDMA: Commissioner and Director of Municipal Administration; PMC: Pune Municipal Corporation; AMC: Ahmedabad Municipal Corporation; HPCL: Hindustan Petroleum Corporation Limited; BSNL: Bharat Sanchar Nigam Limited; CIDCO: City and Industrial Development Corporation; CSC: Common Service Centre; PGVCL: Paschim Gujarat Vij Company Limited; UGVCL: Uttar Gujarat Vij Company Limited; BRPL: BSES Rajdhani Power Limited

5.4. Avenues for Asset Monetization (Non-tariff Revenue)

Avenues which can provide additional revenue, other than the revenue from charging services, can support to improve the profitability of PCS business and help mitigate low utilization risk. Internationally, it is observed that most PCS operators generate non-tariff revenue through marketing/advertisement rights. Box 13 provides one such example.

Box 13: Innovative Business Model with Non-tariff Revenue [25]

Volta Charging provides free EV charging points and supports its business by revenue generated from outdoor advertising at its charging stations. They have more than 1,000 stations across Austin, San Diego, Los Angeles, Portland, Seattle and Chicago, with stations expected to come up in Denver, New York, Atlanta and Detroit.

EESL is also exploring options to generate non-tariff revenue through advertisement/marketing rights provided for PCS in some locations. Locations which may provide such an option are being identified and concepts around non-tariff revenue are being explored by EESL. A case of advertisement at a charging station is provided in Box 14.

Box 14: Advertisement at Charging Station [26]

Static/Video Advertisement at Charging Station in Hawaii

The EV Structure Company operates EV charging stations in Hawaii with monitors displaying advertisement.

06

KEY INSIGHTS FROM THE PROJECT

EESL's roll-out of large-scale PCS in NDMC aimed at designing and implementing a framework for large-scale roll-out of PCS in India. Several learnings emerged in the course of project execution. These learnings have provided essential inputs and key considerations for PCS business. Some of them include.

Aggregation-based business model: To the extent possible, stakeholders exploring the deployment of PCS in a geographical area should come together and aggregate the demand. The demand aggregation business model ensures better control over the investment required. It also avoids over-crowding of PCS in an area, thereby reducing redundant investments. Demand aggregation for the PCS can also enable economies of scale and improve the efficiency of installation by bringing stakeholders together.

Location assessment: A detailed location assessment is essential to identify locations which have better utilization of charging infrastructure and require lower capital investment. Detailed location assessment also helps in effectively estimating the costs involved in getting the power connection, civil works, and auxiliary equipment required for installation of PCS. Deploying PCS at locations which may lead to higher utilization can not only help improve business sustainability but also help build confidence among EV consumers leading to higher EV adoption.

Number of chargers at a location: Availability of power load may restrict multiple chargers at a single location. Some sites may be favourable for installation of a single charger, while others may favour installation of more than one charger (charging hub). A combination of both complements the development of the PCS ecosystem.

Partnerships: Utilization of chargers is a key challenge in PCS business. Partnerships with EV ecosystem players such as EV OEMs and EV fleet operators can help in mitigating the utilization risk. Partnerships can help on several fronts such as creating awareness on EVs and making PCS business more sustainable by improving utilization.

Non-tariff revenue generation: Another way to mitigate utilization risk is to generate non-tariff revenue from the PCS. One such avenue can be selling advertisement/media rights on charging stations.

Land: Cost of land is one of the major costs in the PCS business. To promote sustainable PCS ecosystem, central/state governments need to facilitate the land access for installation of PCS. The governments also need to bring in provisions to ensure that the parking space reserved for EVs, specially EV charging, is not blocked by ICE vehicles.

EV analytics: Analytics on the data from PCS can provide significant insights to different stakeholders. A charger operator can use this data for planning its PCS deployment initiative. Similarly, a power distribution utility can use this data for load management, for shifting of peak load demand through form of time- of-day tariff, etc.

Bibliography

[1] BNEF, "Battery Pack Prices Fall As Market Ramps Up With Market Average At $156/kWh In 2019," Bloomberg New Energy Finance (BNEF), 03 December 2019. [Online]. Available: https://about.bnef.com/blog/battery-pack-prices-fall-as-market-ramps-up-with-market-average-at-156-kwh-in-2019/. [Accessed 16 January 2020].

[2] IEA, "Global EV Outlook 2019," International Energy Agency (IEA), 2019.

[3] M. Kane, "Global EV Sales In November 2019: Down 26% Year-Over-Year," InsideEVs, 31 December 2019. [Online]. Available: https://insideevs.com/news/389990/global-ev-sales-in-november-2019/. [Accessed 16 January 2020].

[4] M. Kane, "In October 2019, 58% Of Car Sales In Norway Were Plug-Ins," InsideEVs, 04 November 2019. [Online]. Available: https://insideevs.com/news/380004/october-2019-car-sales-norway-plugins/. [Accessed 16 January 2020].

[5] M. Kane, "EV Sales In Norway Go Nuts As Tesla Model 3 Rockets To #1 In March," InsideEVs, 01 April 2019. [Online]. Available: https://insideevs.com/news/343710/ev-sales-in-norway-go-nuts-as-tesla-model-3-rockets-to-1-in-march/. [Accessed 16 January 2020].

[6] ICCT, "Overview of global zero-emission vehicle mandate programs," The International Council on Clean Transportation (ICCT), 2019.

[7] A. Hove and D. Sandalow, "Electric Vehicle Charging in China and the United States," Columbia SIPA, Center on Global Energy Policy, New York, 2019.

[8] EV policy, Respective states.

[9] Energy Efficiency Services Limited (EESL).

[10] Charging Infrastructure for EVs – Revised Guidelines & Standards-reg, Ministry of Power, 1 October 2019.

[11] As per Census 2011.

[12] MOSPI, "MOTOR VEHICLES - Statistical Year Book India 2017," [Online]. Available: http://www.mospi.gov.in/statistical-year-book-india/2017/189. [Accessed 16 January 2020].

[13] NDMC Smart City, "About NDMC SMART CITY," NDMC, [Online]. Available: http://smartcity.ndmc.gov.in/pages/home.aspx. [Accessed 16 January 2020].

[14] M. Jones, "Everything You Need to Know About Charging the Hyundai Kona Electric," ChargePoint, 22 March 2019. [Online]. Available: https://www.chargepoint.com/blog/everything-you-need-know-about-charging-hyundai-kona-electric/. [Accessed 16 January 2020].

[15] MG, "ZSEV Brochure," [Online]. Available: https://s7ap1.scene7.com/is/content/mgmotor/mgmotor/documents/mg-dc-pdf-0060.pdf. [Accessed 16 January 2020].

[16] DERC, "Tariff order FY 2019-20," Delhi Electricity Regulatory Commission, Delhi, 2019.

[17] Tariff orders issued by respective SERCs for 2019-20.

[18] As per Industry Interaction.

[19] M. Neaimeh, S. D. Salisbur, G. A. Hill, P. T. Blythe, D. R. Scoffield and J. E. Francfort, "Analysing the usage and evidencing the importance of fast chargers for the adoption of battery electric vehicles," Energy Policy, vol. 108, pp. 474-486, 2017.

[20] A. Fishbone, Z. Shahan and P. Badik, "Electric Vehicle Charging Infrastructure: Guidelines for Cities," Cleantechnica, Warsaw, 2017.

[21] Tesla, "Supercharger," Tesla, [Online]. Available: https://www.tesla.com/supercharger. [Accessed 04 December 2018].

[22] Blink, "Electric Vehicle Charging," Blink, [Online]. Available: https://www.blinkcharging.com/. [Accessed 04 December 2018].

[23] CBC News, "New fine $125 for parking fossil fuel vehicle in electric car spot," CBC, 12 December 2019. [Online]. Available: https://www.cbc.ca/news/canada/kitchener-waterloo/electric-vehicle-parking-fine-1.5394288. [Accessed 14 January 2020].

[24] V. Bøe, "Welcome to the charging station database NOBIL," NOBIL, 10 July 2012. [Online]. Available: https://info.nobil.no/eng . [Accessed 20 December 2019].

[25] K. Korosec, "Volta Charging raises another $20 million to expand ad-supported EV charging network," TechCrunch, 10 September 2019. [Online]. Available: https://techcrunch.com/2019/09/10/volta-charging-raises-another-20-million-to-expand-ad-supported-ev-charging-network/ . [Accessed 03 January 2020].

[26] http://www.evstructure.com/.

Disclaimer & Notice to reader

- This report has been prepared on the basis set out in KPMG Advisory Services Private Limited's ("KPMG") agreement for 'Partnership to Advance Clean Energy 2.0 – "Smart Power for Advancing Reliable and Connectivity" (SPARC)' with the U.S. Agency for International Development ("the Client") dated 25 September 2018.

- Our report may make reference to 'KASPL Analysis'; this indicates only that we have (where specified) undertaken certain analytical activities on the underlying data to arrive at the information presented; we do not accept responsibility for the veracity of the underlying data.

- KPMG has not verified the reliability or accuracy of any information obtained in the course of its work, other than in the limited circumstances set out in the Agreement.

- In preparing the report, KPMG has not taken into account the interests, needs or circumstances of anyone and has not been prepared for the benefit of any other local/international authority, nor for any other person or organization that might have an interest in the matters discussed in this report.

- This report is not suitable to be relied on by any party wishing to acquire rights against KPMG (other than its Client) for any purpose or in any context. Any party other than the Client that obtains access to this report or a copy and chooses to rely on this report (or any part of it) does so at its own risk. To the fullest extent permitted by law, KPMG does not assume any responsibility and will not accept any liability in respect of this report to any party other than the Client.

- In connection with the report or any part thereof, KPMG does not owe duty of care (whether in contract or in tort or under statute or otherwise) to any person or party to whom the report is circulated to and KPMG shall not be liable to any party who uses or relies on this report. KPMG thus disclaims all responsibility or liability for any costs, damages, losses, liabilities, expenses incurred by such third party arising out of or in connection with the report or any part thereof.

- Our views are not binding on any person, entity, authority or Court, and hence, no assurance is given that a position contrary to the opinions expressed herein will not be asserted by any person, entity, authority and/or sustained by an appellate authority or a Court of law.

- The information contained herein is of a general nature and is not intended to address the circumstances of any particular individual or entity. No one should act on such information without appropriate professional advice after a thorough examination of the particular situation.

- Nothing in this report constitutes a valuation or legal advice.

- By reading the report, the reader of the report shall be deemed to have accepted the terms mentioned hereinabove.

Notes

Notes

About EESL

A PSU under Ministry of Power, Energy Efficiency Services Limited (EESL) leads the market-related activities of the National Mission for Enhanced Energy Efficiency (NMEEE), one of the eight national missions under the Prime Minister's National Action Plan on Climate Change. EESL has emerged as the largest energy efficiency service provider globally and has been felicitated for its achievements (Best Public Sector Company – 2018 by Forbes). Government of India has designated EESL as primary implementing firm for mandatory energy efficiency measures in all public

EESL under its national e-mobility programme, launched by the Hon'ble Minister of Power & New and Renewable Energy in 2018, aims to provide an impetus for Indian EV manufacturers, charging infrastructure companies, fleet operators, service providers, etc. to gain efficiencies of scale and drive down costs, create local manufacturing facilities, and grow technical competencies for the long-term growth of the electric vehicle (EV) industry in India.

About USAID's SPARC program

USAID launched the "Smart Power for Advancing Reliability and Connectivity (SPARC)" Program in partnership with the Ministry of Power, Government of India in 2018. SPARC is a three-year (September 2018-September 2021) initiative with the objective of supporting the transformation of operational and financial performance of electricity distribution utilities and facilitating an enabling environment for EVs in India. The implementing partner of the SPARC Program is KPMG Advisory Services Pvt. Ltd.

Apurva Chaturvedi
Senior Clean Energy Specialist
USAID/India
Email: achaturvedi@usaid.gov

Vikas Gaba
Partner
KPMG Advisory Services Pvt. Ltd.
Email: vikasgaba@kpmg.com