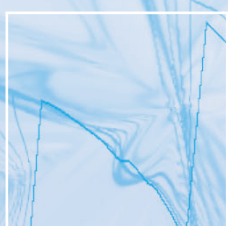
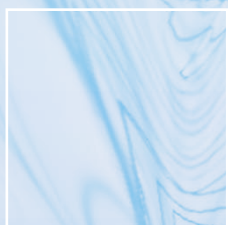


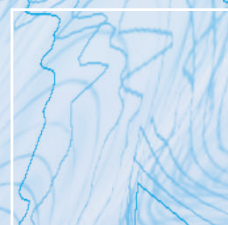
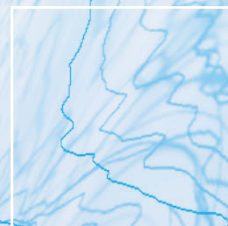
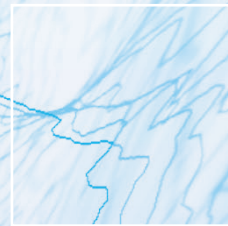


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## Charging up India's Electric Vehicles

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### Highlights

- India's ambitious electric mobility targets are highly dependent on the availability of robust charging infrastructure and readiness of the power system to integrate the additional flexible EV load.
- Indian policymakers at state and national level are proactively pursuing actions for developing EV charging infrastructure (EV service providers) on supply-side and EV users' (demand side). Further enhancements for supply-side can come from the role of distribution companies (DISCOMs), tariff design, incentives, permitting processes and data privacy, and on the demand side from payment methods, minimum facilities, charging station user registration and consumer complaints.
- EV charging business in India is at its early stage, and it has a large scope for business model innovation. As EV penetration increases and market grows, innovations can be expected in the areas of service provision, partnership and pricing.
- EV load can increase peak demand and distribution grid congestion. Solutions are emerging to avoid more investment in generation and network capacity such as time-varying tariff and flexibility measures taken by the DISCOM to deal with these issues.
- V2X is still in an early stage but would become relevant as the market matures. The accuracy in predicting the availability of V2X resource and minimising market entry barriers for V2X service provision can be improved through aggregation, allowing smaller minimum bid volumes and contract periods, asymmetric products and shorter lead times.
- The search for the most appropriate solutions would benefit from regulatory sandboxes both at the national and state level.

POLICY BRIEF



## Introduction<sup>1</sup>

India has embarked on an ambitious path towards more sustainable mobility by promoting the electrification of its transport sector. The push for electric vehicles is driven by the global agenda established under the Paris Climate Agreement to reduce carbon emissions, and by the national agenda, which includes improvement of air quality in its urban areas, reduction of dependence on oil imports, and encouragement of the local EV manufacturing sector.

The country has set a target of 30% electric vehicle sales across all vehicle types by 2030. To achieve this, NITI Aayog, with the support of select central ministries, has been serving as the nodal agency to develop the electric mobility plan for India. Although the e-mobility plan is established at central level, the onus is on the state governments, which have to develop policies and regulatory frameworks to enable the adoption of EVs and the deployment of charging infrastructure in their respective states.

India has over 250 million vehicles, and this fleet is dominated by 2-wheelers, accounting for 78% of the total amount, followed by 4-wheelers and 3-wheelers. Currently, EVs represent a minimal share with approximately 750,000 vehicles. Amongst the different vehicle characteristics, public buses, taxi fleets, 2-wheelers and three-wheelers are expected to be the first adopters of EVs. As the country is at an early stage of EV deployment, public charging infrastructure is still limited. In this regard, the Ministry of Power has already identified 9 major cities and 11 intercity routes as pilots to enable EV charging infrastructure. Similarly, a number of states have also started introducing policies to promote EV adoption and charging infrastructure deployment.

The rapid growth in EV uptake required to reach India's policy targets will have to address two major

challenges. **The first challenge** is ensuring the deployment of the **charging infrastructure** required to serve the needs of the ever-growing number of EVs. This raises two questions:

- What policies and regulatory frameworks are required to enable the efficient deployment of charging infrastructure?
- What business models can reach the sufficient coverage of charging infrastructure that meets the needs of the EV user?

**The second challenge** is the integration of the EVs into the **power system** securely and efficiently. This raises two questions:

- How can the potential impacts of the additional EV load in the power system be managed?
- How can the flexibility potential of Vehicle-to-X (V2X) be unlocked?

The study aims to provide a vision for the future of EV charging infrastructure deployment and power system integration via a **toolbox** consisting of solution choices and recommendations for addressing each of the questions mentioned, by:

- assessing the current state and national policies for EV charging infrastructure deployment;
- identifying business models being implemented in India and key business innovation trends from practices in countries at the growth stage of EV adoption;
- assessing current practices for managing the impacts of the additional EV load in the power system and identifying insights from international practices; and
- providing insights on unlocking the flexibility potential of EVs with V2X capability.

1. This policy brief summarise the key findings from the FSR report "Charging up India's electric vehicles: infrastructure deployment and power system integration" (2019), Bhagwat P. C., Hadush S. Y., Bhagwat S. R. K.



## 1. Policies to enable charging infrastructure deployment

EV policies in India are proactively pursuing the development of EV charging infrastructure. Under India's constitutional structure, the responsibility of policymaking for EV charging infrastructure deployment is shared between the central government and the state governments. Consequently, several Indian states have developed EV policies. Furthermore, the central government's Ministry of Power has also introduced guidelines for the deployment of public charging infrastructure. These policies cater to the charging infrastructure used for both fleets (B2B) and individual consumers (B2C). The recommendations can be categorised as those for enabling the supply-side (the EV charging service provider) and the demand-side (user of the EV charging infrastructure).

*The recommendations on the supply-side* can be further categorised based on whether these are applied at the introductory, growth or a mature stage of market development.

*During the introductory and the growth stage*, 1) it is recommended to mandate a time-bound, single-window clearance for permissions required to develop charging stations; 2) policymakers should clarify within the EV policy the long-term role of state-owned utilities that are at the forefront of EV charging station deployment. Furthermore, as the EV charging market takes off and starts to follow demand, 3) it can be recommended to reassess the approach to EV charging tariff structure periodically; 4) Incentives for installing EV chargers should be recalibrated to ensure that coverage in remote or low demand areas is not forgotten; 5) the EV policy must include some provisions for the development of frameworks to ensure ethical handling and use of user data and privacy.

*As the market nears the high level of maturity*, 6) policymakers must consider developing a regula-

tory framework for the utilisation of V2X capabilities, which can be a valuable resource. A cost-benefit analysis can become the basis for deciding the extent to which V2X should be enabled and incentivised.

*The demand-side* can be enabled by improving the customer experience in terms of ease of use.

From this perspective, 1) EV policy should specify a comprehensive set of minimum payment methods to be made available to the consumer at the charging station. 2) Provisions should be developed for minimum facilities required at the public charging station based on the Government of India guidelines. 3) A harmonised intra/inter-state registration process for using charging infrastructure should be developed, thus allowing the use of the wider network. 4) Finally, it can also be recommended that policymakers proactively take a step within the EV policy by mandating minimum standards for a mechanism to address consumer complaints. Table 1 provides summary of the assessment results.

## 2. Business model innovation to enable EV charging services

The business model of EV charging in India is *at the introductory stage*, with the focus being on kick-starting the market. *The dominant business model* is the provision of charging solutions to business (B2B) such as bus and taxi fleets with some B2C service providers. The current charging station roll-out is led by Utilities and Public sector undertakings (PSUs) with limited but growing private sector involvement. Hence, there is a large scope for business innovation in India's EV charging space.

This study looked at case studies of EV charging business models from the market that are currently *in the "growth" stage of development*. This is intended to provide some indication of possible pathways for innovation and evolution of the EV charging business models in India in the near future. Case studies of growth stage markets indicate that as the market



Table 1: Assessment of state policies and national guidelines on EV charging

Dimensions	Elements	KA	MH	AP	TS	KL	DL	UP	UK	Gol
Enabling EV charging on supply-side	Definition of fundamental market design framework to limit distortions and entry barriers	Treated	Treated	Treated	Treated	Treated	Treated	Treated	Treated	Treated
	The incentive for launching the EV charging market	Treated	Treated	Treated	Treated	Treated	Treated	Treated	Treated	Treated
	Prioritisation in terms of EV characteristics and social geography	Treated	Not treated	Treated	Treated	Treated	Treated	Treated	Treated	Treated
	Elimination of administrative barriers for establishing charging stations	Not treated	Treated	Treated	Not treated	Not treated	Not treated	Not treated	Not treated	Not treated
	Mandate on user data sharing and privacy	Not treated	Not treated	Not treated	Not treated	Not treated	Not treated	Not treated	Not treated	Treated
	Mandate on the utilisation of V2X capabilities	Not treated	Not treated	Treated	Not treated	Not treated	Not treated	Not treated	Not treated	Not treated
Enabling EV charging on demand-side	Technical standardisation of chargers for interoperability	Treated	Not treated	Treated	Treated	Treated	Treated	Not treated	Not treated	Treated
	The mandate for the development of digital platforms and database management systems	Not treated	Treated	Treated	Not treated	Treated	Treated	Not treated	Not treated	Treated
	Specification of the use of a wide range of payment methods	Not treated	Not treated	Not treated	Not treated	Not treated	Treated	Not treated	Not treated	Not treated
	Specification of minimum facilities required at the charging stations	Not treated	Not treated	Not treated	Not treated	Not treated	Not treated	Not treated	Not treated	Treated
	Harmonisation of Intra/interstate registration for using charging infrastructure	Not treated	Not treated	Not treated	Not treated	Not treated	Not treated	Not treated	Not treated	Not treated
	Establishment of a mechanism to address consumer complaints	Not treated	Not treated	Not treated	Not treated	Not treated	Not treated	Not treated	Not treated	Not treated

Treated in the policy

Not treated in the policy

develops, there is *greater competition in the market* arising from higher private sector participation. The focus shifts from providing basic vehicle charging to innovation in incorporating *more value-added services* in their offerings and how these services are offered.

*Innovation in business models* is evident in three key areas, namely; services, partnerships, and pricing (See Table 2). Within service innovation, businesses are promoting retailing of green power, providing a choice between multiple speeds, multiple sockets, multiple power retailers, and developing software applications for users. Partnership innovation is

focused on ensuring increased access to the wider charging network and partnering with actors that specialise in a particular service; pricing innovation is occurring in the offering of subscription. In varying combinations, charging subscriptions provide users preferential rates, while access subscriptions provide priority access to the wider network.

As India increases its EV penetration, business models will evolve as the sector transitions from introductory stage to the growth stage, where the focus could be on incorporating one or more of the innovation attributes as presented in Table 2.



Table 2: Innovation trends in EV charging businesses

EV charging businesses	Service innovation		Partnership innovation		Pricing innovation	
	Green retailing	Additional services	Access to a wider network	Service Specialisation	Charging Subscription	E-roaming Subscription
Ubitricity	✓	✓	✓	✓	✓	✓
Plug N Go	✓	✓		✓		
IZIVIA	✓	✓	✓	✓	✓	✓
Nuvve		✓		✓	✓	
Fastned	✓	✓	✓	✓	✓	✓
Share&Go		✓	✓	✓		
Allego		✓	✓	✓		✓
EnelX		✓		✓	✓	✓

### 3. Managing the additional EV load in the power system

EV as a load represents a unique additional electrical load that is mobile, power-dense, variable and mostly connected to the distribution grid. Therefore, starting from the introductory stage of EV market development, the long-term power system planning should anticipate the growth of EV adoption and deployment of charging infrastructure while considering the unique characteristics of the load.

Forecasts for 2030 indicate that the total energy consumption of EVs in India will be approximately 3% of total demand, and it can be accommodated

without a significant impact on the power system. However, as the EV market enters the growth stage, if the charging of EV is not well distributed in terms of time and location, it may lead to: a) high cost of electricity supply due to the increase in peak demand, and b) grid ageing and service interruption due to congestion in the distribution grid.

Conventionally, utilities would invest in additional new generation and distribution capacity (wire or storage) to ensure adequacy at any time and location of consumption. This way peaks are accommodated, and the possibility of congestion is significantly reduced. However, *various solutions are emerging* as alternatives to help defer these investments (see figure 1).

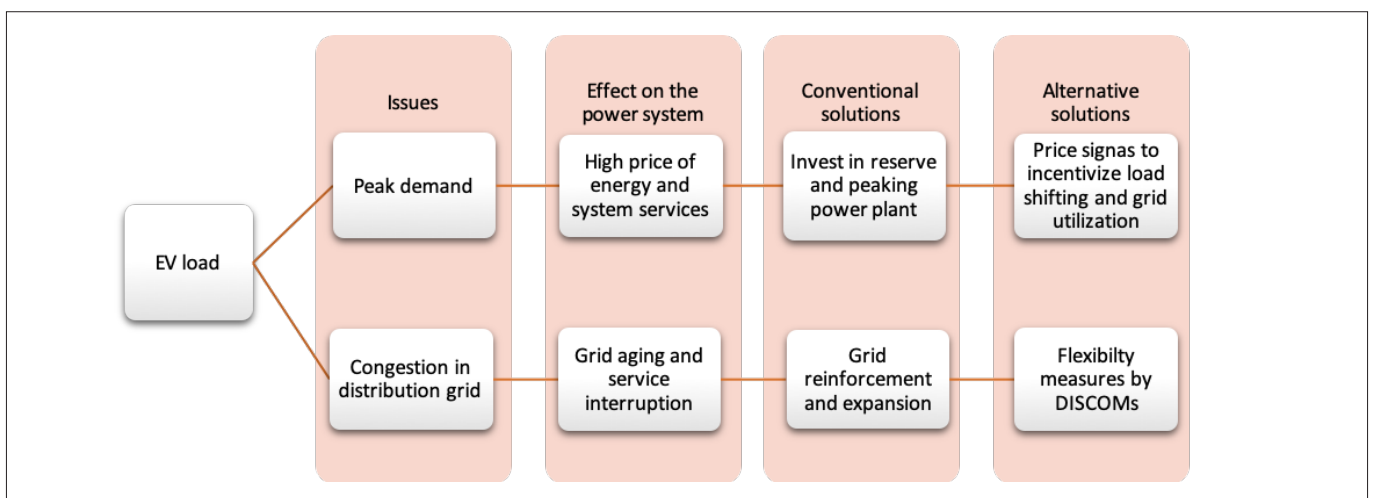


Figure 1: Potential issues caused by additional EV load, and their effects and solutions



*First, the peak demand contribution of EVs* can be reduced by sending price signals to EVs, both for B2B and B2C charging, to shift charging to off-peak hours through time-varying energy tariffs (e.g., time of day and real-time pricing) and demand tariffs. However, the application of such tariff designs in India is challenged by the low penetration of enabling technologies such as smart meters, even though the solutions are compatible with the current regulatory framework. This can be addressed by introducing mandatory standards for charging stations to be equipped with the required technologies and encouraging business model innovation to reduce the upfront cost of enabling technologies. Moreover, the effectiveness and acceptance of these price signals depend on the flexibility and price sensitivity of the EV user. This can be improved by encouraging innovative business models where intermediaries (e.g., aggregators) play a role of optimizing and directly controlling EV charging by considering price signals and the mobility needs of the EV user.

*Second, to deal with distribution grid congestions*, proactive measures should be prioritised. These include, regularly publishing state of the grid information to encourage optimal siting of charging infrastructure and integrating the anticipated EV adoption and

infrastructure into the grid planning process. With the increase in penetration of enabling technologies and EV adoption, more sophisticated solutions such as variable capacity contracts and flexibility markets for congestion management services can be considered.

*The choice of appropriate solutions will depend* on the development of the EV and power sector. This includes the growth in EV adoption, penetration of enabling technologies, the maturity of the wholesale and retail market, and the severity of congestion in the distribution grid. Consequently, the influx of EV in the system needs to be considered in the long-term power system planning process, leading to an efficient mix of conventional and alternative solutions to deal with the peak demand and congestion issues.

#### 4. Insight on V2X application of EVs

EVs as flexibility source with V2X capability can offer *various V2X services in the future*. Currently, the concept of V2X is still in an early stage of development globally. In the context of India, where the EV sector itself is in a nascent stage, V2X services would become relevant in the future when the market is at

Table 3: Assessment of V2X service attributes

Service Attributes →		Volume	Contract Period	Product Symmetry	Location	Lead time	Reservation Period
Constraints	Range	✓		✓	✓		
	Time		✓			✓	✓
Solutions	Smaller min volume	✓					
	Smaller min contract period		✓				
	Shorter lead time			✓	✓	✓	✓
	Asymmetric products			✓			
	Aggregation	✓	✓	✓	✓	✓	✓



a mature stage of development. Nevertheless, proactive policymaking will aid in ensuring that the full potential of the V2X services can be utilised.

In this context, *four recommendations on the V2X regulatory aspects* are provided, keeping in mind the perspective of individual EVs with varying characteristics, thus relevant for both fleets (B2B) and individual consumers (B2C). The accuracy in predicting the availability of V2X resource at a given time and location by the provider can be improved and the market entry barriers for EVs to provide V2X be minimized by 1) enabling aggregation of EVs to provide V2X resources. 2) Allowing smaller minimum volume and minimum contract period for trade. 3) Allowing trade of asymmetric products (for instance upward and downward balancing products). 4) Having a lead time that is as short as possible, from the time of commitment to the time of provision of the service, will allow better forecasting and reduce risk of unavailability. Table 3 provides summary of the assessment.

## Summary of recommendations

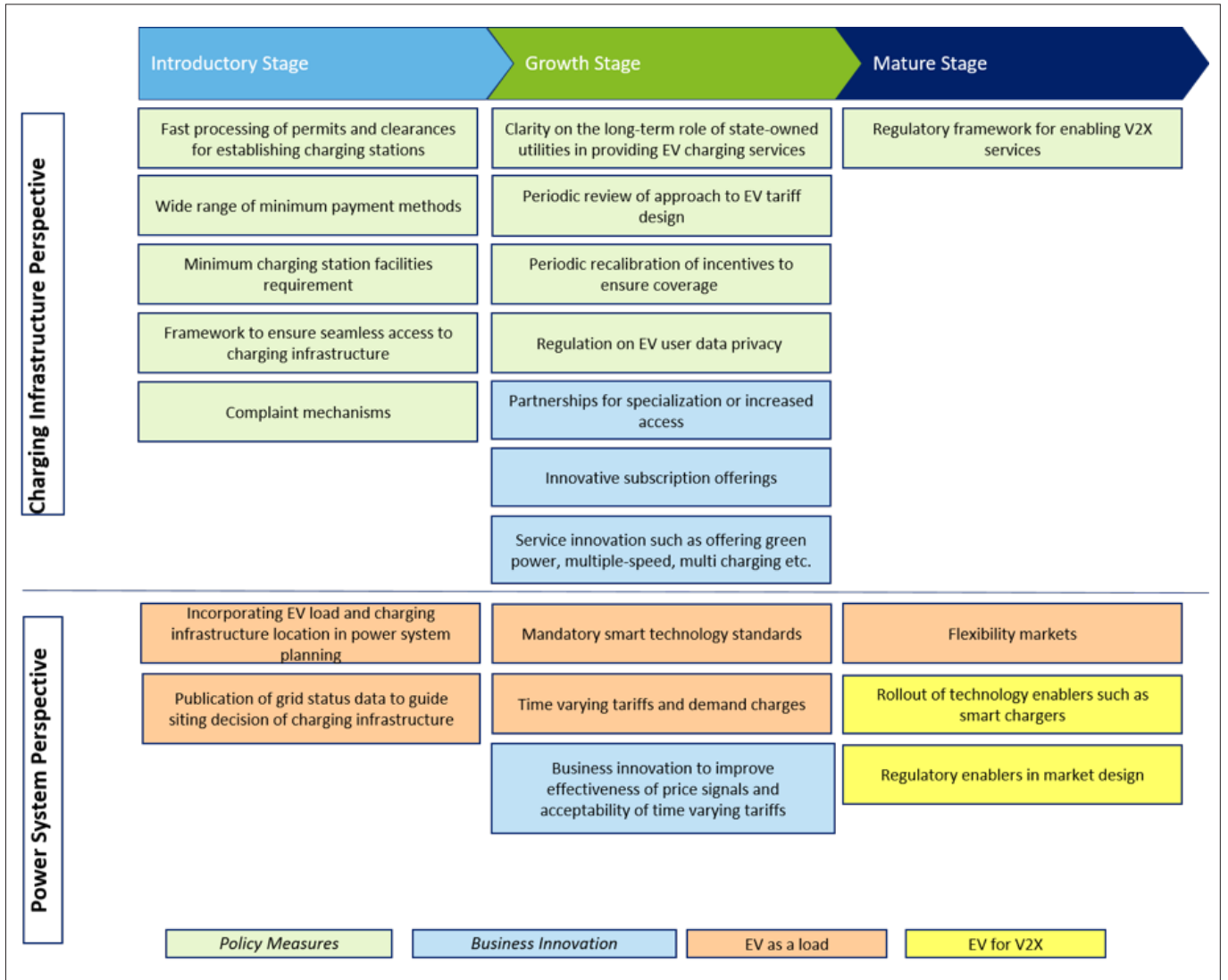
*The challenge of charging infrastructure deployment and the planning and management of the power system to accommodate the EV influx go hand in hand.* While some measures are focused on enabling solutions to address these two challenges, some others are focused on issues and tools that need to be factored in the future while the EV market in India moves from introductory to growth to mature stages. Figure 2 summarizes the relevance of the various elements within the toolbox in the context of the EV market development stages.

Importantly, the EV challenges discussed in this study should be viewed in the context of *the overall energy transition and disruptive innovations* that are shaping the power sector of the 21st century. This calls for the development of *smart infrastructure* alongside smart users and smart use of data to capture values through *innovative business models*. Finally, the search for the most appropriate solu-

tions in this time of change should be supported by regulatory sandboxes both at the national and state level that help test different solutions to gain better insights.



Figure 2: Relevance of the various elements within the toolbox in the context of EV market development stages







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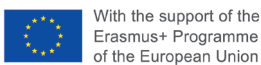
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