Prioritising Measures for EV Integration
- Insights from Asian Emerging EV Markets

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EV stock dominated by LDVs. Will managing EV charging load be a challenge?

- Two representative EV markets: India, Vietnam

What are the risks?

Exacerbating existing evening peak demand and/or causing night-time secondary peak

- Majority of distribution utilities experience evening peaks which may also be the time when large number of EVs will get charged

Overloading at the distribution level

- Ageing distribution network; low available hosting capacity of many feeders
- Private chargers for e-2Ws/ e-3Ws having limited communication & control capability; concentration of such charging in residential locality
- Possible less use of dedicated EV charging connection; distribution utility to have limited visibility of new load

Abbreviations: LDV (Light Duty Vehicle), EV (Electric Vehicle), e-2W (electric two-wheeler), e-3W (electric three-wheeler)
Ways for smooth integration with grid

Value in Grid Flexibility Services

Levels of VGI

- Time-of-use pricing without automated control
- Smart Charging (V1G)
- Aggregated Smart Charging
- Large-Scale Bidirectional Charging (V2G)

Value Streams

- Passive, Smart Charging, V2G
- Peak shaving
- Arbitrage opportunities
- Frequency regulation
- RE offtake
- Passive, Smart Charging, V2G

Three primary use-cases:
- Passive Measures
- Aggregated Smart Charging with Passive Measures
- Large-Scale V2G

Abbreviations: VGI (Vehicle-Grid Integration), V2G (Vehicle to Grid), RE (Renewable Electricity)
Techno-economic comparison

- V2G enables a **greater range and value** of grid flexibility services, but involves **highly complex technological factors** → **higher cost** of implementation

- Passive measures like ToD tariffs are **easy to implement**, but offer **limited grid benefits** unless complemented by smart charging → a near-term solution

- Smart charging supported by passive measures is apparently an **attractive proposition**.

- Important that **distribution utilities, regulators, CPOs, and policymakers** in developing countries take note of techno-economic advantages and challenges
  - Should consider **local context**, which varies from country to country and province to province

**Source:** Vehicle-Grid Integration – A New Frontier for Electric Mobility in India

**Abbreviations:** ToD (Time of Day), CPO (Charge Point Operator)
As-is analysis - select Asian developing countries

<table>
<thead>
<tr>
<th>Key requirements</th>
<th>India</th>
<th>Vietnam</th>
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<tbody>
<tr>
<td>Passive Measures</td>
<td></td>
<td></td>
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<tr>
<td>ToD/ ToU tariffs</td>
<td>• For certain consumer types in some states; no dynamic ToU</td>
<td>• Specific consumer categories; no dynamic ToU</td>
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<tr>
<td>Demand charges</td>
<td>• Currently applicable in some states (recommendation from Ministry to waive off till March 2025)</td>
<td>• Currently not applicable</td>
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<td>Dedicated metered electricity connections</td>
<td>• Not mandatory (conditional in states where there is separate EV tariff)</td>
<td>• Very few PCS installed currently; no regulatory requirement</td>
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<tr>
<td>Aggregated Smart Charging</td>
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<tr>
<td>Programmable chargers</td>
<td>• Limited adoption, mostly for e-4W charging (smart control features disabled in most cases)</td>
<td>• No reported adoption; very few PCS installed currently</td>
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<tr>
<td>Adoption of uniform communication protocols at different levels</td>
<td>• Yet to be formally recognised (OCPP, OCPI and OpenADR expected to be adopted)</td>
<td>• No consideration currently</td>
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<tr>
<td>Large-scale V2G</td>
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<tr>
<td>Ancillary service market</td>
<td>• Yet to mature (required regulation notified in January 2022); resource aggregation not clearly recognised</td>
<td>• Does not exist</td>
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<tr>
<td>V2G supporting EVSE and EV</td>
<td>• Not available</td>
<td>• Not available</td>
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<tr>
<td>Pilot projects</td>
<td>• Few initiatives by technical institutions</td>
<td>• No reported case</td>
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Abbreviations: ToU (Time of Use), EVSE (EV Supply Equipment), PCS (Public Charging Station), e-4W (electric four-wheeler), OCPP (Open Charge Point Protocol), OCPI (Open Charge Point Interface), OpenADR (Open Automated Demand Response)
Possible roadmap for emerging EV markets (1/2)

Guiding principles

- Cost-effective implementation
- Uncomplicated participation of EV users, CPOs and distribution utilities
- Alignment with existing laws and regulations
- Avoiding immediate need for expensive grid upgrades
Possible roadmap for emerging EV markets (2/2)

**Passive Management (Inception Phase)**
- ToD tariffs for EV
- Interconnectivity regulations
- Standards for programmable chargers
- Stipulation on data sharing and monitoring
- Guidelines for private and public EV charging
- Programmable, inexpensive chargers (with pre-set charging functions) for private charging
- Mode 3/ Mode 4 EVSEs for e-4W charging
- Smart meters at facility level

**Aggregated Smart Charging**
- Demand charges (on actual recorded load)
- Real-time ToU tariffs
- OCPP for EVSE-charging network comm.
- OCPI for e-roaming
- OpenADR for communication with distribution utility
- Distributed Energy Resources Management System for utility to manage and leverage DERs
- Aggregation of resource and access to multiple markets (including ancillary)
- OCPP-compliant smart charging infrastructure with remote monitoring and control facility
- Advanced telematics in EVs

**Large-scale V2G**
- Access to all types of power markets
- Net/ gross metering regulations
- Regulation on vehicle warranty
- Widespread deployment of V2G-enabled charging system
  - Bidirectional inverter; control units for reliable and safe battery charging & discharging; Loss of Mains protection equipment; two-way metering capability
- EV models with V2G functionality
  - Capable to discharge DC or AC power; with advanced BMS

**Basis:**
- Level of maturity of the local e-mobility and power markets
- Status of VGI internationally
- Unique set of challenges and value proposition for each intervention
  - Achievement of one regarded as the stepping-stone to the next level.
- Smart charging is neither contingent on complex and expensive new EV or charging technologies nor requires significant regulatory and market reforms
  - Price signals the most important tool

Abbreviations: DER (Distributed Energy Resources), DC (Direct Current), AC (Alternating Current)
Distributed charging infrastructure with battery swapping to complement

- Concentration of charging points, especially of high-power chargers, increases feeder-level loading.
- Providing charging points in a distributed manner helps limit local power demand, enables use of ubiquitous low-voltage lines.
- Battery charging outside EVs for swapping allows controlled charging at low power.
- These are viable options for Asian developing countries considering the high share of e-2Ws and e-3Ws.

For details, please refer to:
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