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India Smart Grid Forum

DISTRIBUTION UTILITY MEET DUM 2024

Experience from Vehicle-to-Grid (V2G) Pilot Demonstration

Session : Session - 7: RE, EV and Grid Stability and Challenges of 10 Million Rooftop Solar PV Systems

Presented By

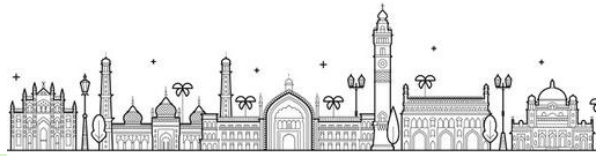
Prof. Zakir Rather, IIT Bombay

(zakir.rather@iitb.ac.in)

GRID INTEGRATION LABORATORY
IIT BOMBAY

Distribution Utility Meet | 14 - 15 November 2024 | www.dumindia.in

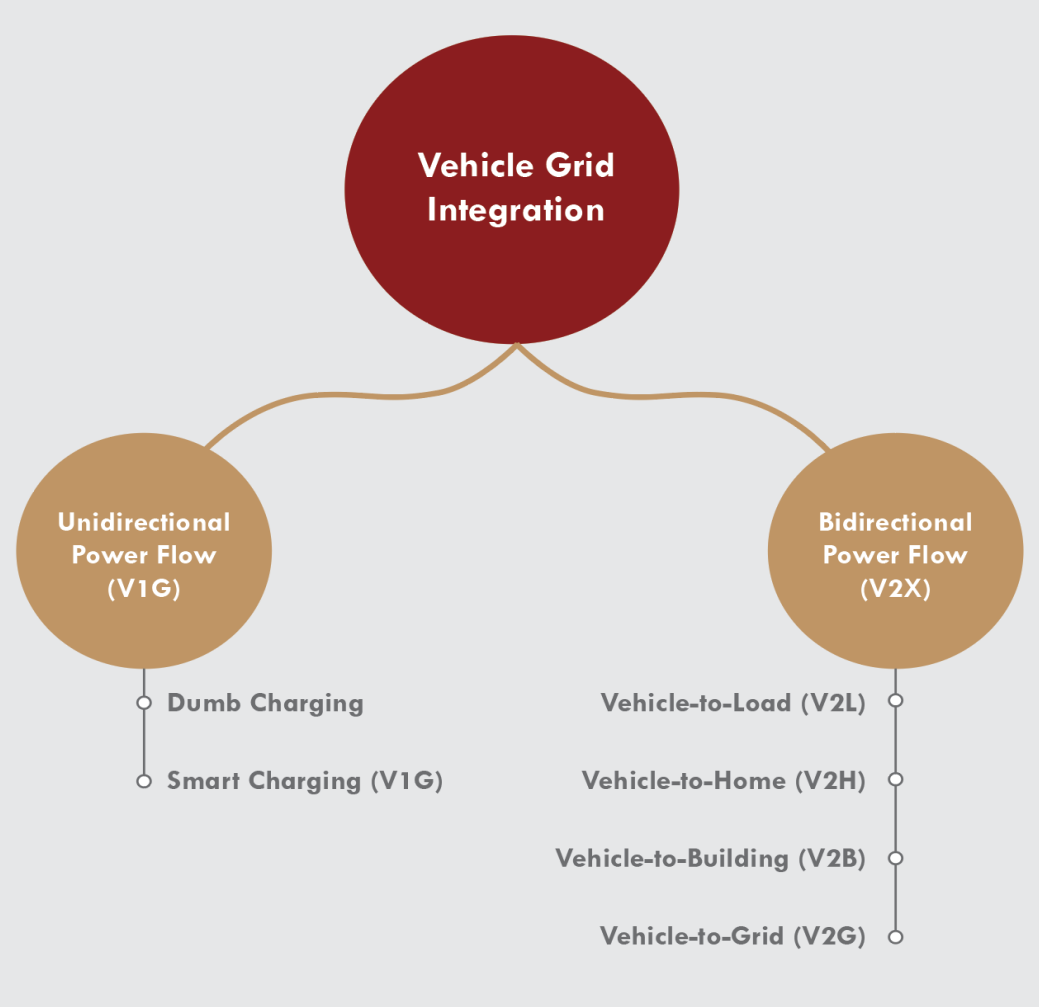




Vehicle-to-Everything (V2X)

Vehicle-to-Everything (V2X) is a part of VGI and it is the use of EV batteries, sitting idle and not being currently used for mobility purposes, to provide valuable power back to 'everything'

- **Vehicle-to-grid (V2G)** if the EV is feeding power back to the electrical grid
- **Vehicle-to-home (V2H)** if the EV is feeding power to the home
- **Vehicle-to-building (V2B)** if the EV is feeding power to a building
- **Vehicle-to-load (V2L)** if the EV is feeding power to an individual load
- **Vehicle-to-vehicle (V2V)** if the EV is feeding power to a different vehicle.



V2X Field Demonstrations taken up by IIT Bombay

- **V2X Field Demonstrations**
  - **Field Demo-I**
    - IIT Bombay Campus
      - **Pilot-1**
        - V2G/V2H
      - **Pilot-2**
  - **Field Demo-II**
    - Public RE based EV Charging Station in Pune
      - **Pilot-3 and Pilot-4**
  - **Field Demo-III**
    - *Large size with a DISCOM*

Components of Pilot-1

Electric vehicle

Bidirectional charger

Solar PV system

Home loads

Home Load	Quantity	Average Power Consumption (single unit)
Air conditioner(with evaporative cooling)	2	480 W
Lamp load	1	1200 W
LED Trim Panel Light	33	2 W
Tube Light	5	15 W
Microwave Oven	1	1100 W
Ceiling Fan	6	30 W
Exhaust Fan	5	10 W
Television	1	60 W
Computer	1	50 W
Electric Chimney	1	55 W
Total Connected Load		3796 W

Objectives

Objective of the Pilot-1:

1. **Electric Vehicle (EV) Integration**
2. **Peak Shaving**
3. **Increased PV Utilization**
4. **Islanded Operation of house**
5. **Net Zero Electricity Exchange**

Testing phase – II : Peak shaving

1. Electric Vehicle (EV) Integration

2. Peak Shaving

3. Increased PV Utilization

4. Islanded Operation of house

5. Net Zero Electricity Exchange

6. Additional Vehicle to Grid (V2G) Applications

Objective:

Household power supplied by EV instead of grid during peak hours

Peak hours	Off-peak hours
07:00am - 10:00am	10:00am – 07:00pm
07:00pm – 10:00pm	10:00pm – 07:00am

- During off-peak hours : Household loads are supplied by the grid
- During peak hours : Household loads are supplied by the EV and excess power is sent to the grid

Testing phase – IV : Islanded operation of house

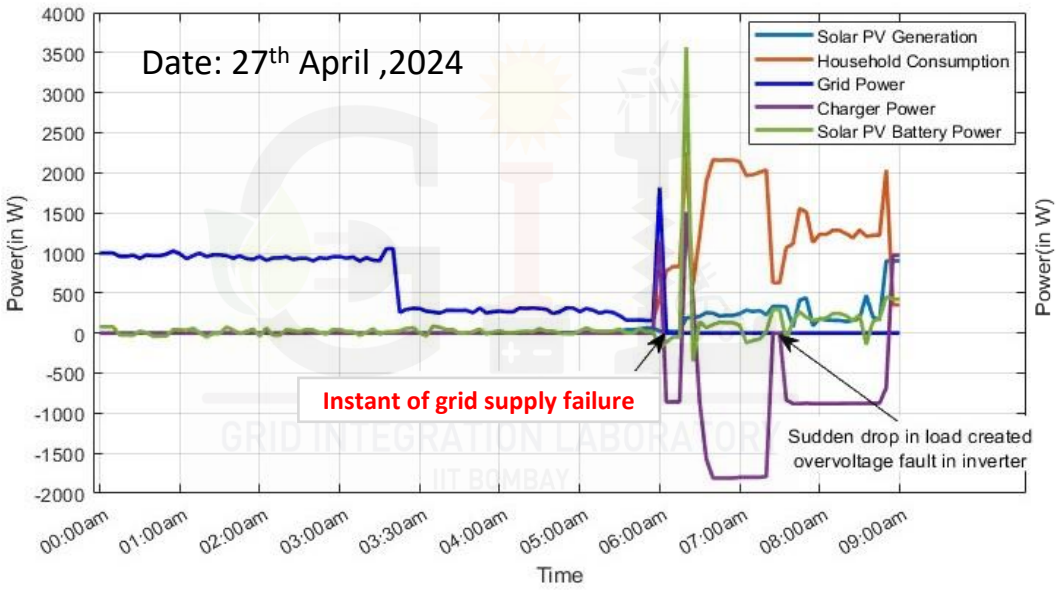
1. Electric Vehicle (EV) Integration
2. Peak Shaving
3. Increased PV Utilization
4. **Islanded Operation of house**
5. Net Zero Electricity Exchange
6. Additional Vehicle to Grid (V2G) Applications

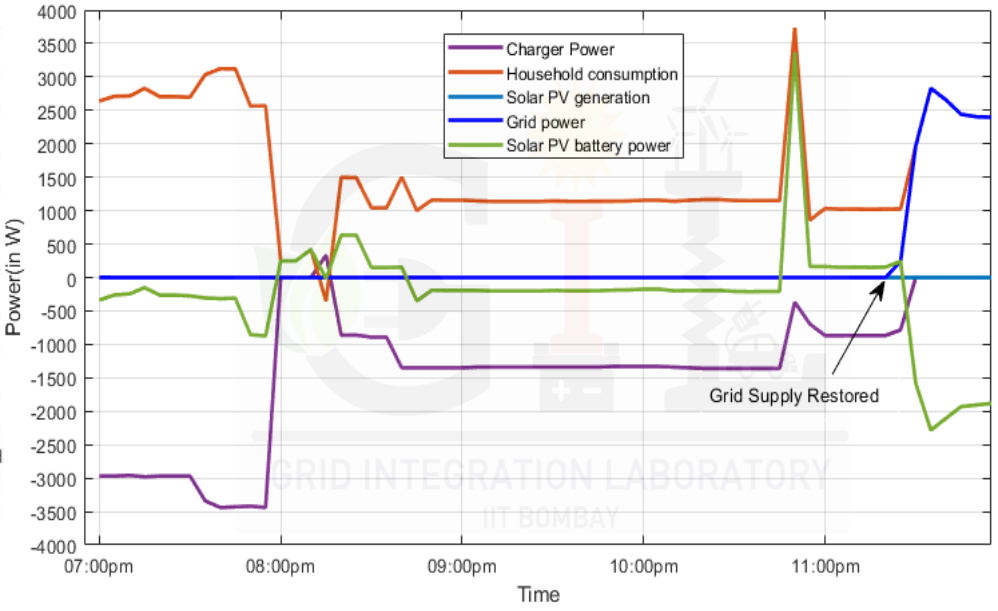
Objective:

To operate the house in islanded condition with EV and PV

PV power is available from 07:00am – 06:00pm

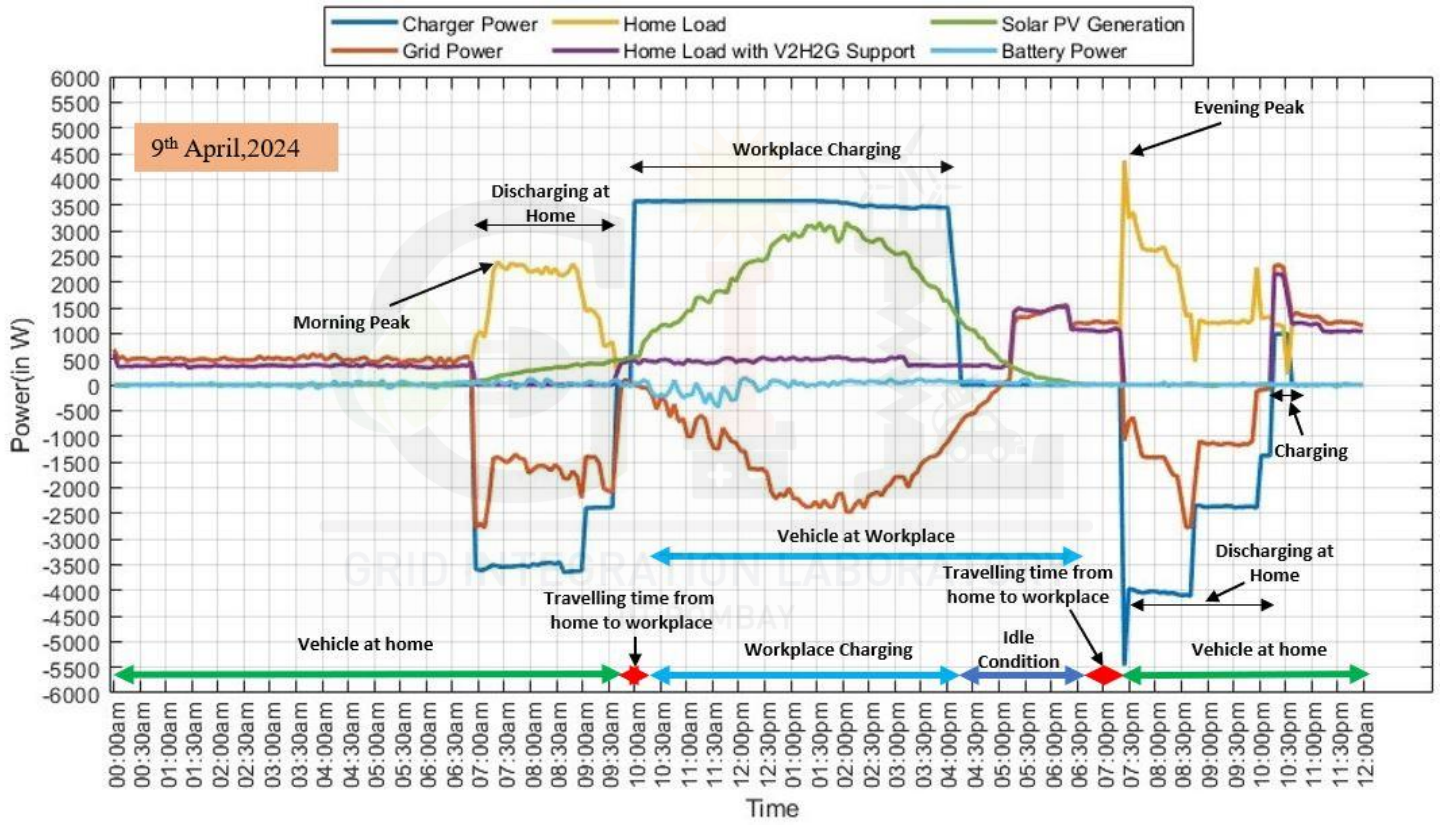
Peak hours	Off-peak hours
07:00am - 10:00am	10:00am – 07:00pm
07:00pm – 10:00pm	10:00pm – 07:00am

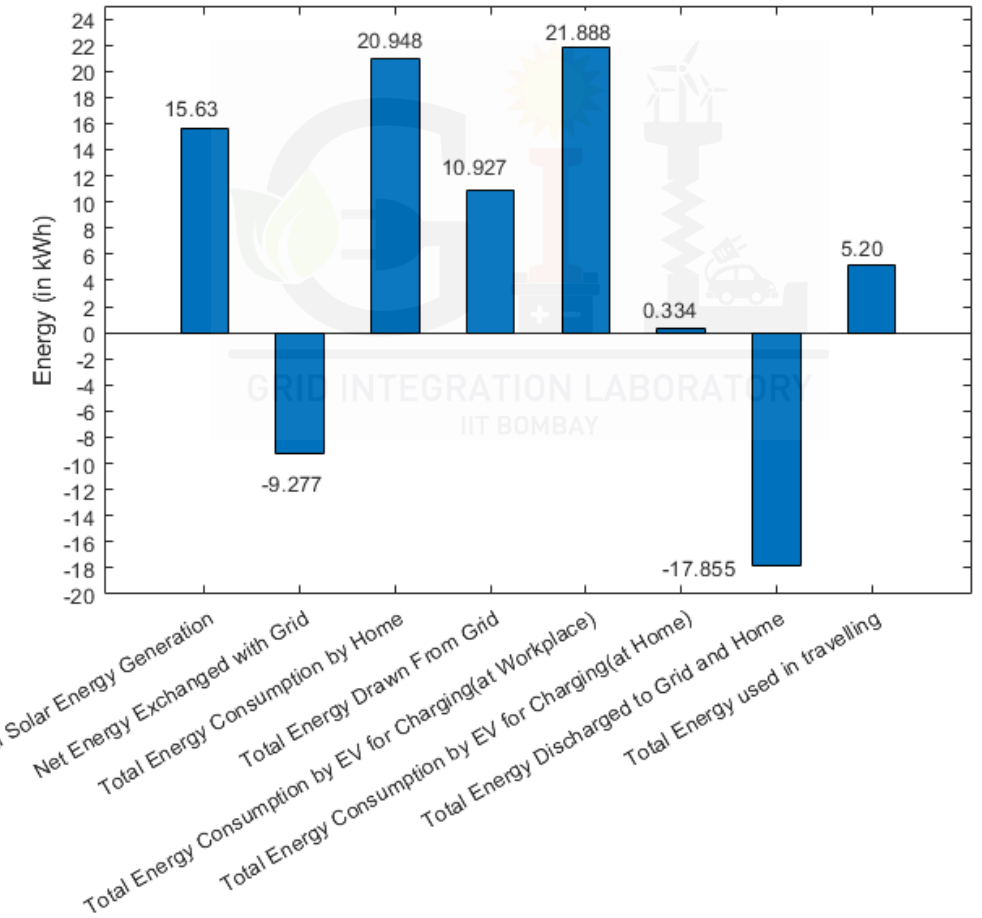




- When grid supply is disconnected, EV supplies to the household loads
- When the grid supply is restored, EV is disconnected and grid supplies to the household loads

Sample Day Measurements - V2H2G





Rate schedule for LT-Residential(Mumbai)			
Consumption slab(kWh)	Fixed/Demand Charge	Energy Charges	Wheeling Charges
0-100	Three Phase – Rs. 385.00 per month	4.71	1.17
101-300		10.29	1.17
301-500		14.55	1.17
>500		16.64	1.17

Rate schedule for LT Non-Residential or commercial(Mumbai)			
Consumption slab(kW)	Fixed/Demand Charges	Energy Charges	Wheeling Charges
0-20	Rs. 517.0/Month	4.71	1.17
TOD Tariffs (in addition to above base Tariffs) (Rs/kWh)			
2200Hrs - 0600 Hrs			-1.50
0600 Hrs - 0900 Hrs &1200 Hrs - 1800 Hrs			0
0900 Hrs - 1200 Hrs			0.80
1800 Hrs - 2200 Hrs			1.10

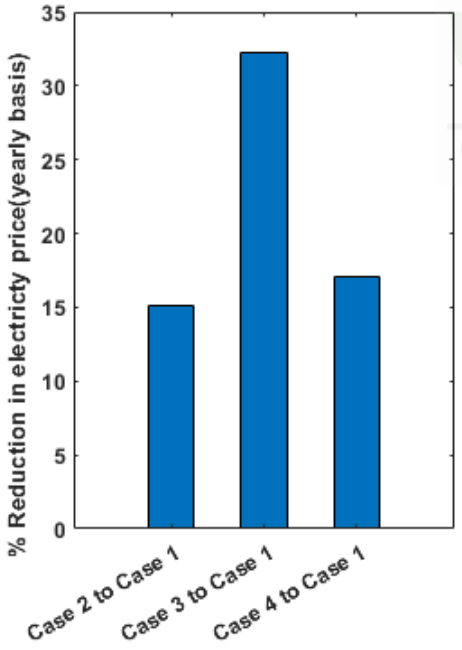
Rate schedule for LT – EV Charging Stations(Mumbai)			
Consumption slab(kWh)	Fixed Charge(Rs./kWh)	Energy Charges	Wheeling Charges
All units	80.0	6.58	1.17
TOD Tariffs (in addition to above base Tariffs) (Rs/kWh)			
2200 Hrs-0600 Hrs			-1.50
0600 Hrs-0900 Hrs & 1200 Hrs-1800 Hrs			0.00
0900 Hrs-1200 Hrs			0.80
1800 Hrs-2200 Hrs			1.1

Feed-in tariff as per MERC: 3.34 Rs./kWh

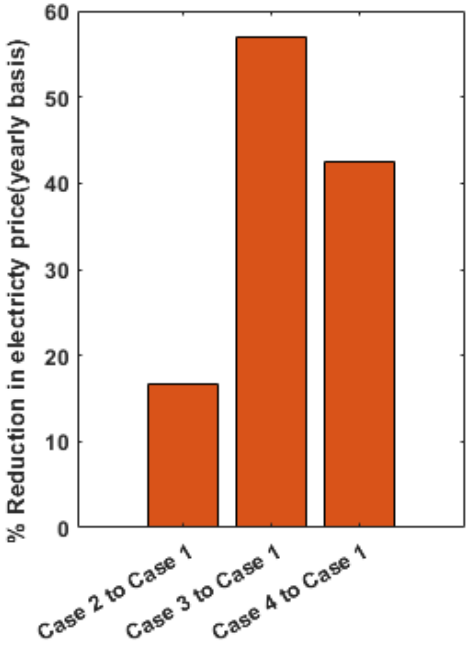
Source: Maharashtra Electricity Regulatory Commission Tariff order,2023-24

Economic analysis

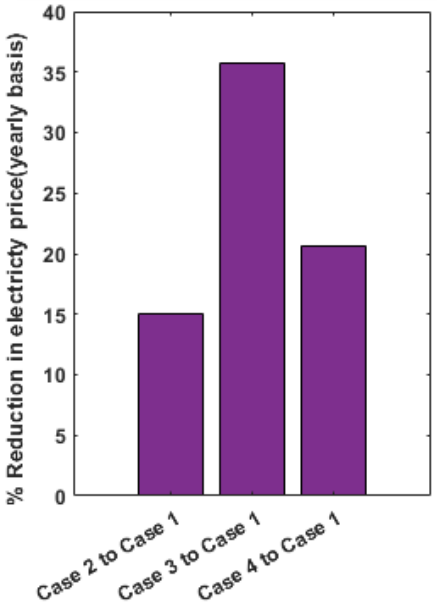
Senario 1: Flat electricty price for residential customer with EV home charging



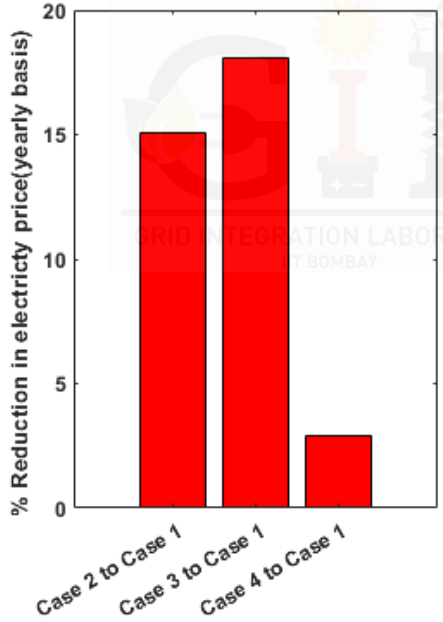
Senario 2: ToD based electricity tairff for LT Non-residential or commerical premises with EV home charging



Senario 4: Flat electricity price for residential customers with EV being used for V2G Support using net metering (Note: Charging is also done through net metering

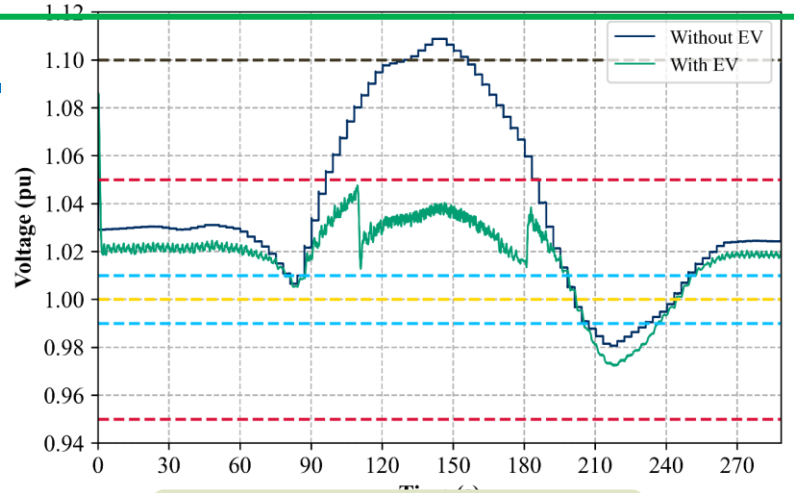


Senario 3: Flat electricity price for residential customers with EV home charging at ToD based tariff

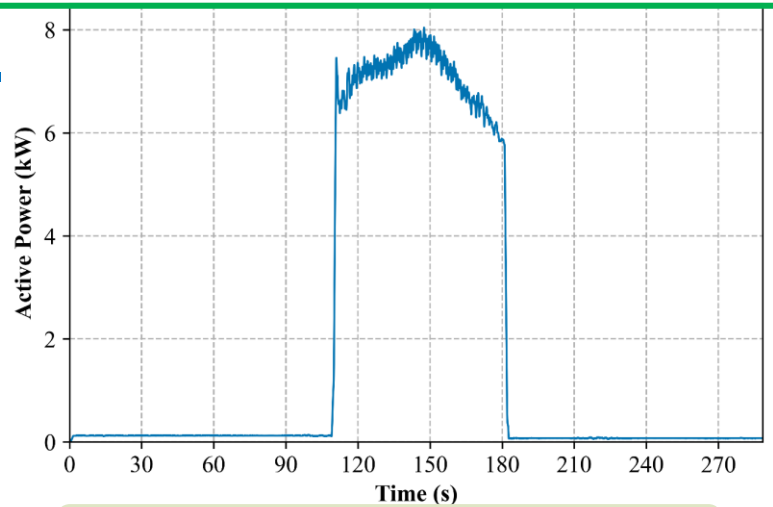


Case 1: No V2H2G and No Solar PV generation
Case 2: No V2H2G Support but Solar PV generation is present
Case 3: Both V2H2G Support and Solar PV generation is present
Case 4: No Solar PV generation but V2H2G Support is present

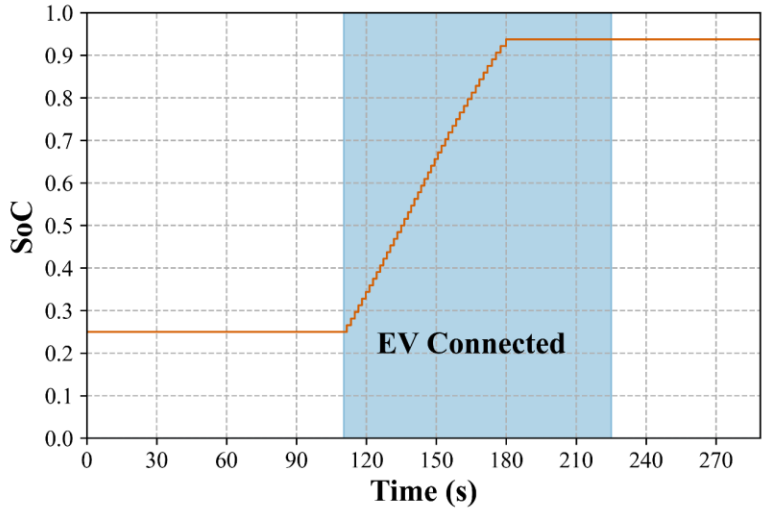
Addressing rooftop PV driven overvoltage in distribution system



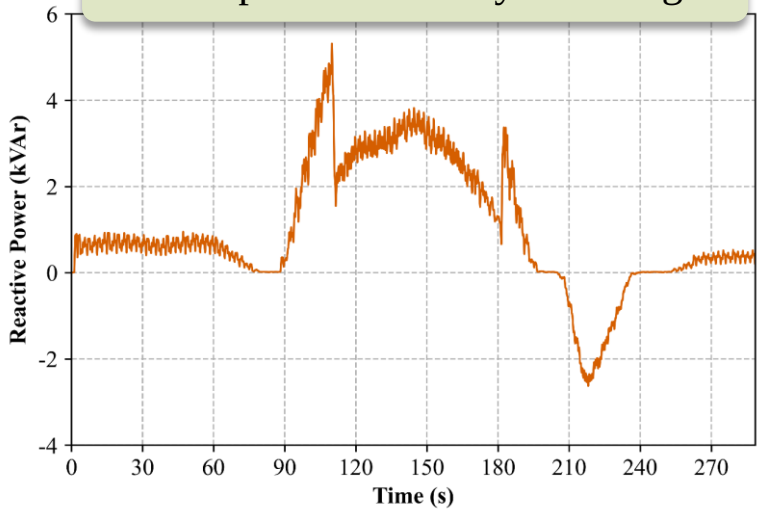
per unit voltage



Active power drawn by the charger



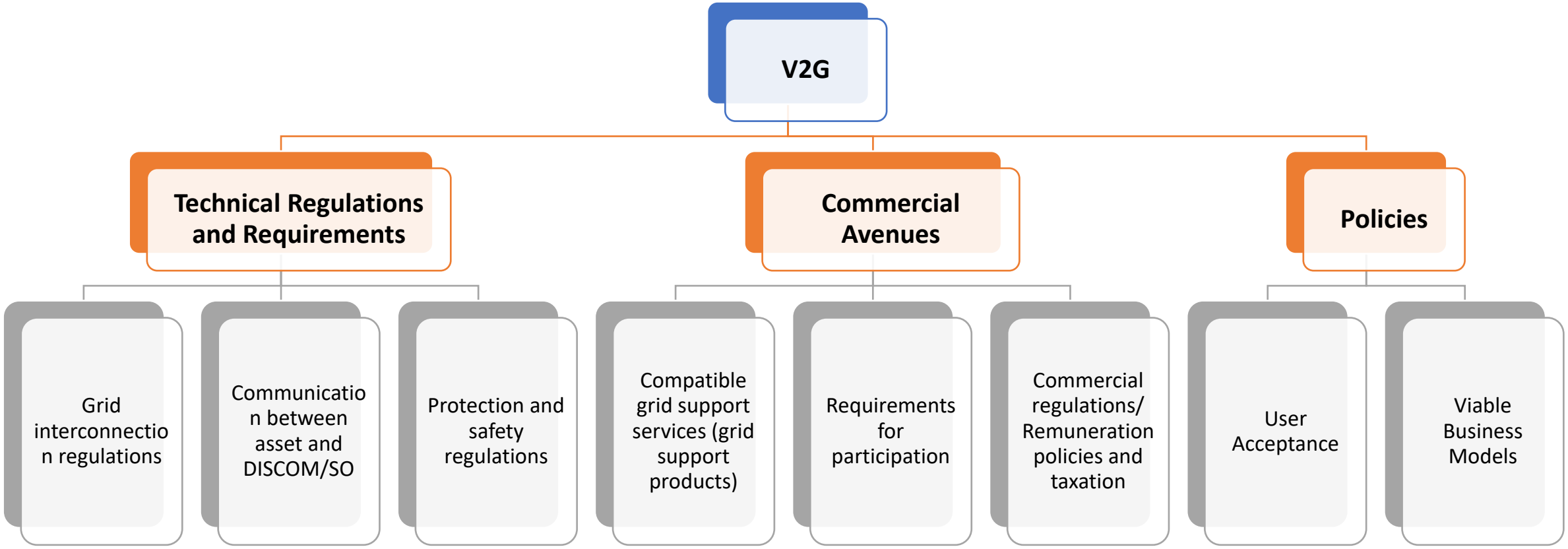
SoC variation with time



Reactive power exchanged by the charger

Enabling V2G in India

- Depending on the V2X application, there are multiple requirements to enable V2X in India.
- Besides V2X capable hardware requirements, the necessary regulations, standards and policies are the major enablers of V2X.



IMPLEMENTATION OF VEHICLE-TO-EVERYTHING (V2X) IN INDIA

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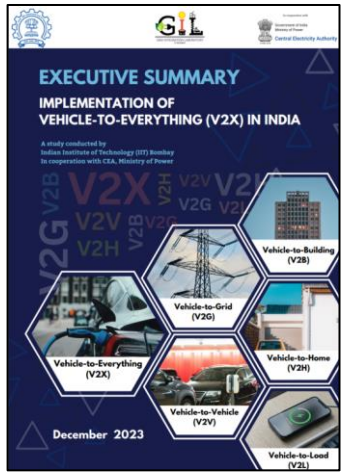
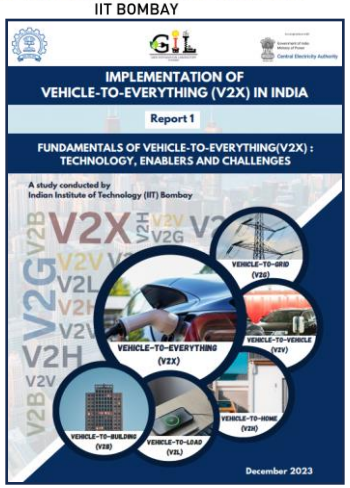
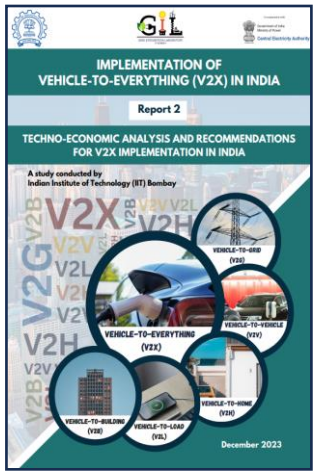
Government of India
Ministry of Power
Central Electricity Authority



Executive Summary



Report 1: Fundamentals of Vehicle-to-Everything(V2X): Technology, Enablers and Challenges



Report 2: Techno-economic analysis and recommendations for V2X implementation in India

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THANK YOU

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