



# EVs Impact on PQ in Grid



Enabling Smart and CleanTech Markets

-  Energy
-  E-Mobility
-  LVDC
-  Enviro
-  Urban

-  Research
-  Consulting
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-  Data

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# Technology & Business Models Convergence is around

EVs

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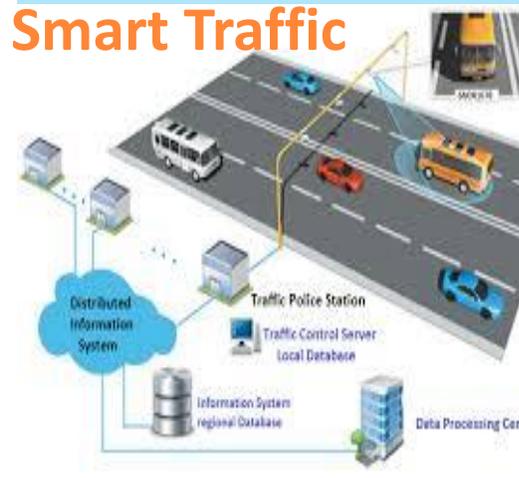
Solar

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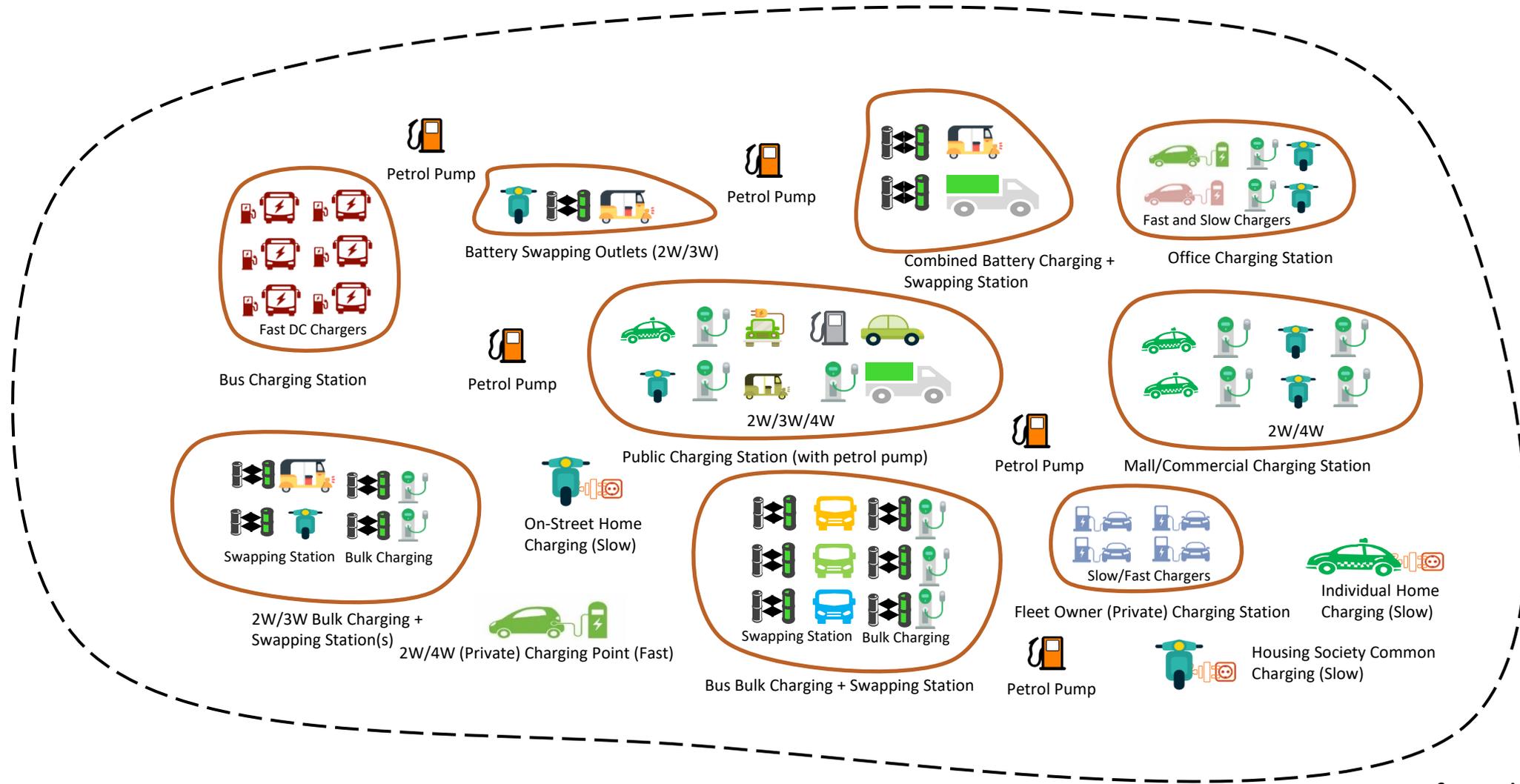
Grid Storage

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V2G



# Multiple EV Charging Options (AC/ DC/ Battery Swap) will co-exist at City Level across EV modes (2W, 3W, 4W, Buses) and Locations of Charging



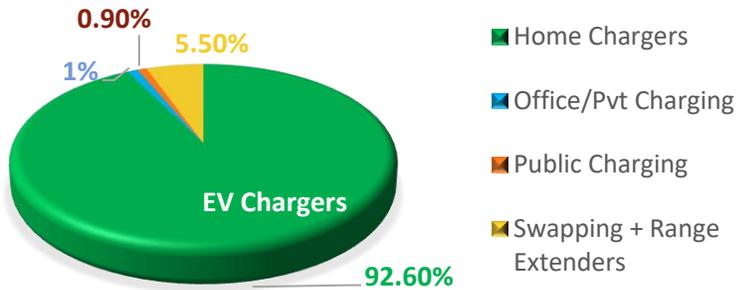
Source: pManifold

**1** Battery Swapping can come in >30% EVs, 12% LIB market, >30% no. of charges

**4** Optimisation potential with 4-12% kWh and 12-27% Peak Load contribution from EVs



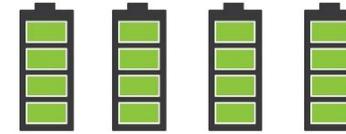
	Scenario 1	Scenario 2
% EV Sales in 2030	100%	30%
Total EVs on road	~ 256 million	~ 84 million
% EV Share of Total Vehicle Stock	41%	14%



	Scenario 1	Scenario 2
EV/EVSE ratio (without home chargers)	~ 19	~ 15

**2** Home + Office + Dedicated charging will form >60% no. of charges and >56% kWh. >90% Home chargers.

**3** Public charging <10% no. of charges, and some 7% kWh



EV Lithium Ion Batteries (LIBs)

	Scenario 1	Scenario 2
Total Capacity Connected	~ 1045 GWh	~ 338 GWh
- Integrated LIBs	88%	88%
- Swapping + Range Extender LIBs	12%	12%



Impact on Grid

	Scenario 1	Scenario 2
Total Peak Load (including EVs)	464 GVA (27% EV contribution)	428 GVA (21% EV contribution)
Total Electricity Consumption (including EVs)	2,900 TWh (7% EV contribution)	2,820 TWh (4% EV contribution)

# Why Power Quality?

While sizing the charging equipment, we usually worry about balancing the energy and peak power demands.

But power quality is also a very important factor to be addressed in selection and sizing of charging equipment. Power quality drives factors like equipment compatibility with the grid and transients in the demand.

Some of the major power quality related issues are...

**Voltage:** Deviations of supply voltage, both – continuous (> 60 s) and dynamic – above or below the minimum utilization voltage of charging system. This can cause non-optimal performance of the distribution or charging systems and even failures.

**Frequency:** Deviations in supply frequency from the specification due to large transients in demand. This can cause rapid fluctuations in supply voltage putting the charging equipment at risk.

**Harmonics:** Distortions in the current waveform harmonics can cause vibrations, buzzing, equipment distortions, and losses in as well as overheating of transformers.

More than the demand magnitude, the demand transients affect power quality...

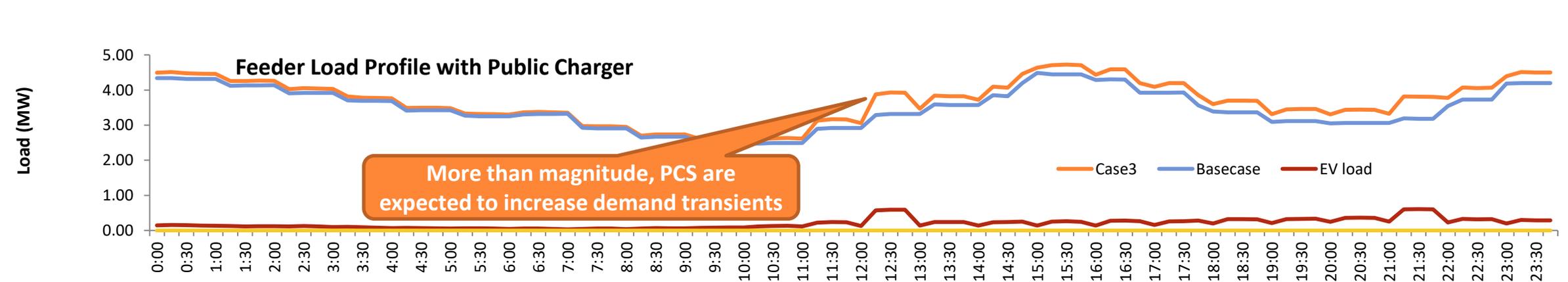
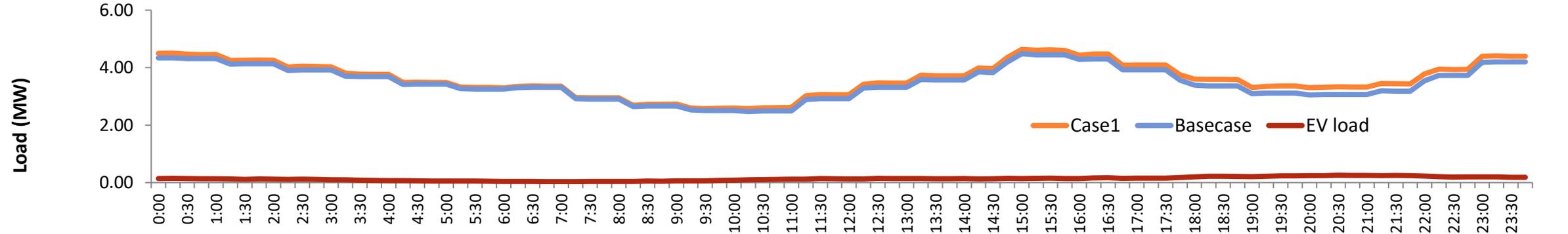
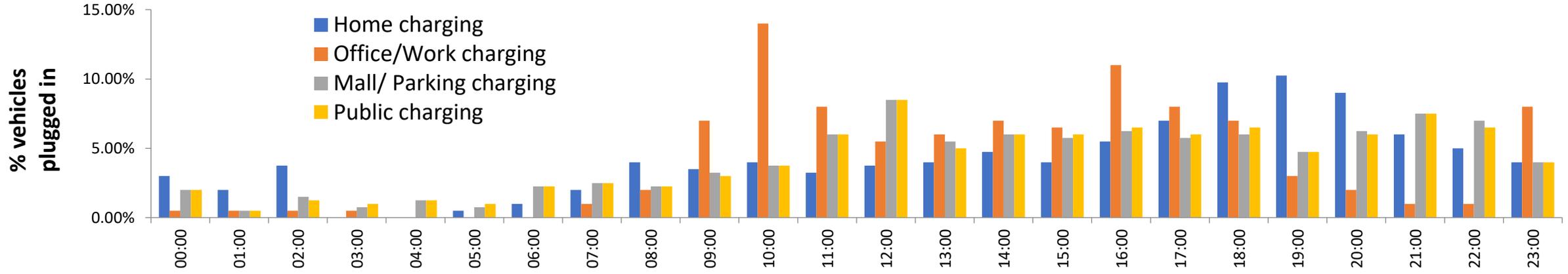
# Possible Transients due to EV Fast Chargers Typical with Public Charging

Charger Level & Supply	Power	Voltage	Max. current	Illustrative charge time for 100 km range
Typical Level 1 1-Φ AC	3.3 kW	230 V AC	16 A	5 – 6 hours
Level 2 1-Φ AC	7.4 kW	230 V AC	32 A	2 – 2.5 hours
Level 1 3-Φ AC	11 kW	400 V AC	16 A	1.5 – 2 hours
Level 2 3-Φ AC	43 kW	400 V AC	63 A	~ 0.5 hours
Level 3 DC	120 kW	300–500 V DC	300–350 A	~ 10 minutes

		CHARGING LOCATION			
		HOME	WORK/ PVT.	PUBLIC	COMMERCIAL
VEHICLE SEGMENT	2-WHEELER	Slow AC	Slow AC	Slow AC	Slow AC
	3-WHEELER	Slow AC	Slow/Fast AC	Slow/Fast AC	NA
	4-WHEELER	Slow AC	Slow/Fast AC Fast DC	Slow/Fast AC Fast DC	Slow/Fast AC Fast DC
	BUSES	NA	Fast DC >= 100kW	Fast DC >= 100kW	NA

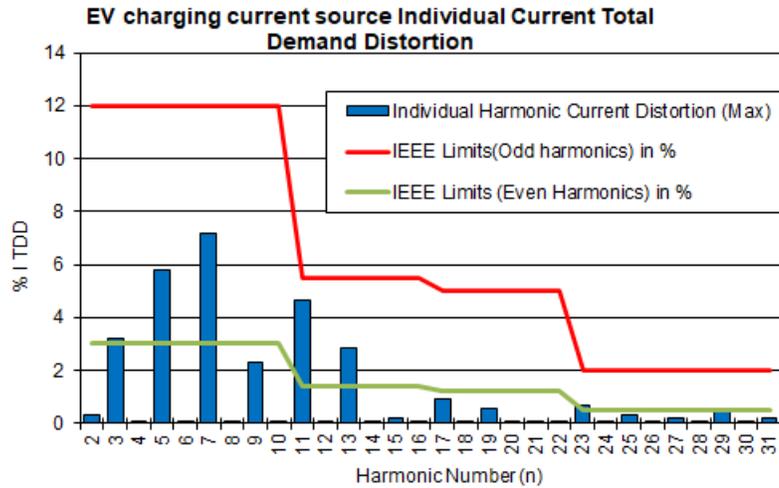
Turning on/off fast chargers can induce transients of the order of 10-100 kW per charger!

# Case study: EVs impact on Grid – Daily Charging Demand over Base (Peak Power)



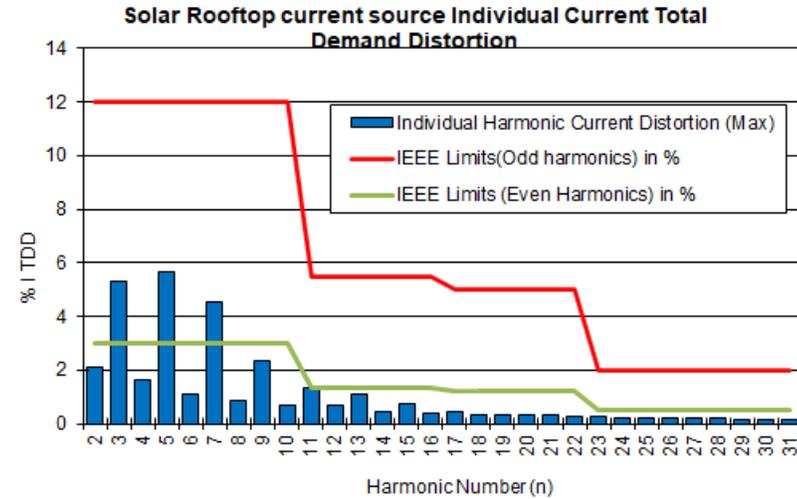
Source: PRDC, pManifold, GIZ

# Case study: Janta-Colony Feeder – Monthly Transients (Odd & Even Harmonics)



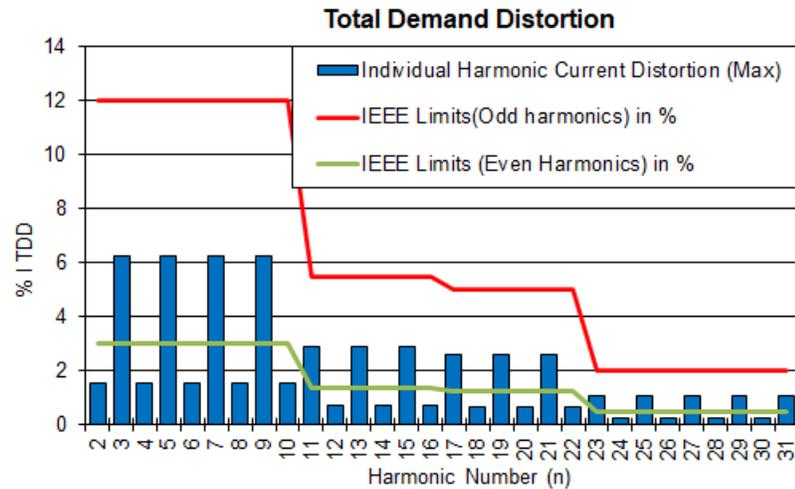
**Scenario-1:** Harmonics injection from EV charging points and solar rooftop generations

**Case-1:** Injection of EV charging harmonics into the grid



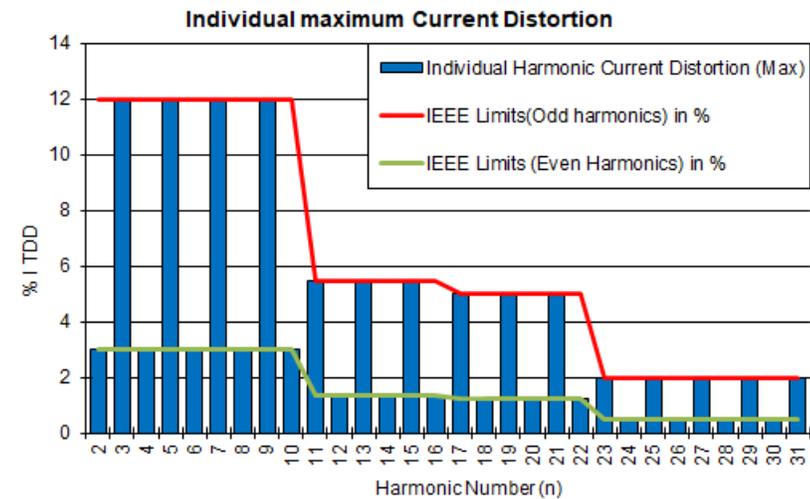
**Scenario-1:** Harmonics injection from EV charging points and solar rooftop generations

**Case-2:** Injection of EV charging harmonics into the grid along with solar PV inverter harmonics



**Scenario-2:** Harmonics injection as per limits provided in IEEE standard

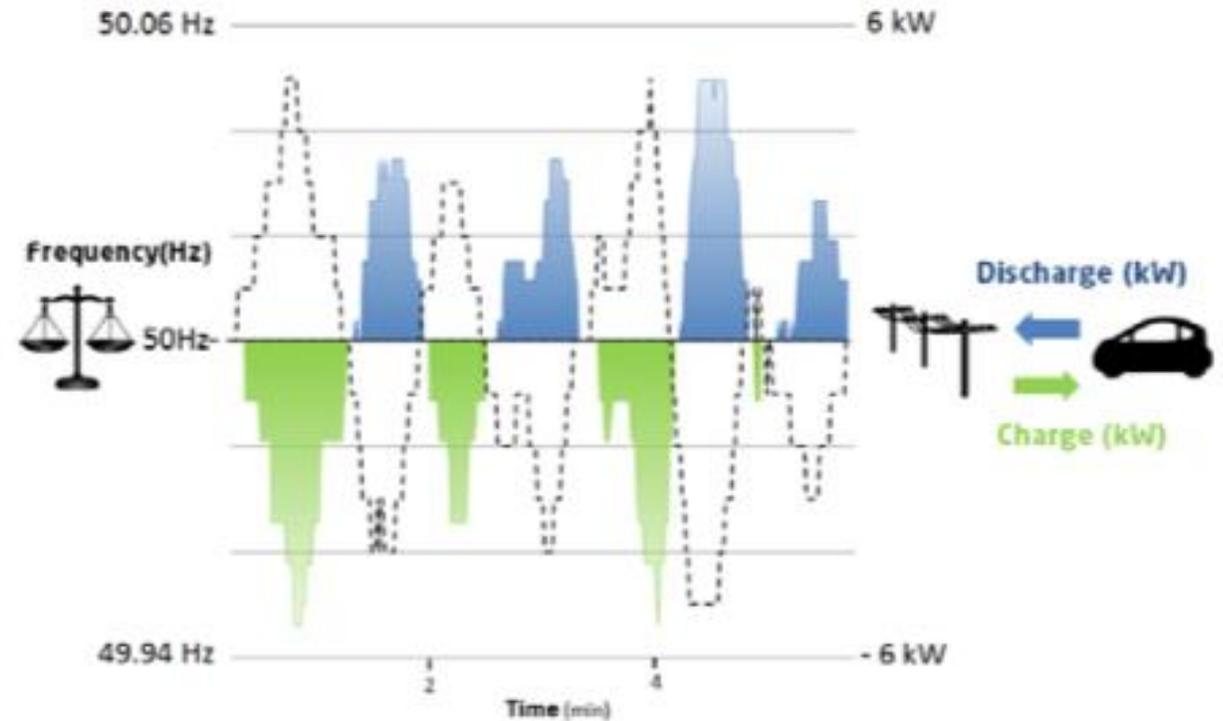
**Case-1:** Maximum Current Total Demand Distortion (ITDD) as per IEEE standards



**Scenario-2:** Harmonics injection as per limits provided in IEEE standard

**Case-2:** Maximum Individual harmonic currents distortion as per IEEE standards

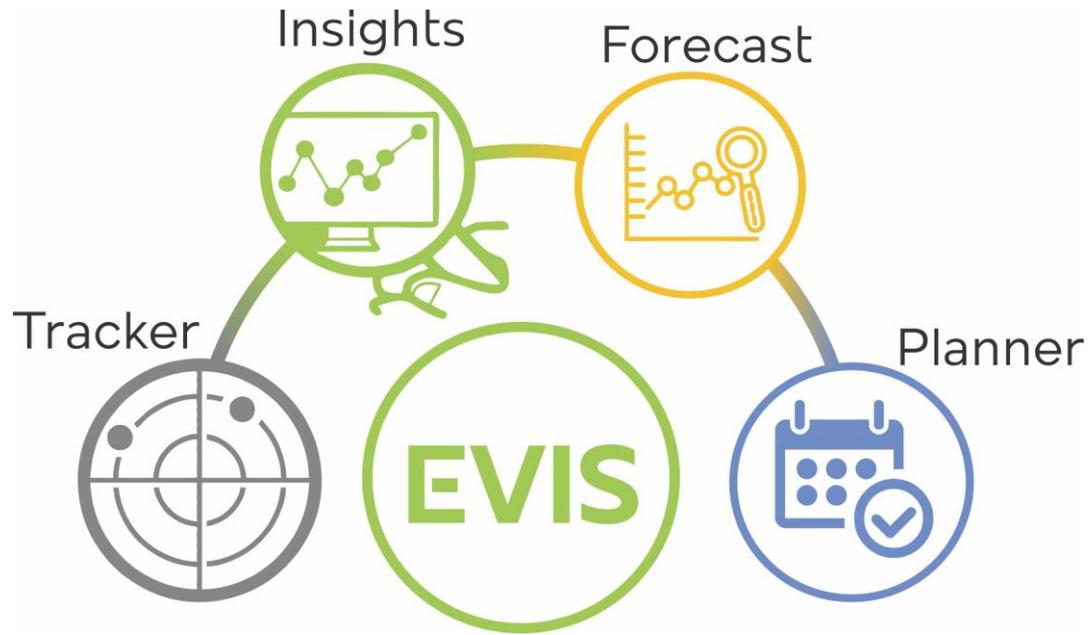
# V2G Preparedness in India



**Basic technical feasibility exists. Next steps could be:**

- Pilots to be identified
- Frequency market to be developed
- Standard Discom communication protocols to be developed
- Smart control charging linked to Time of Usage (ToU)

Source: DTU



# Biggest CITY EV Data Platform

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