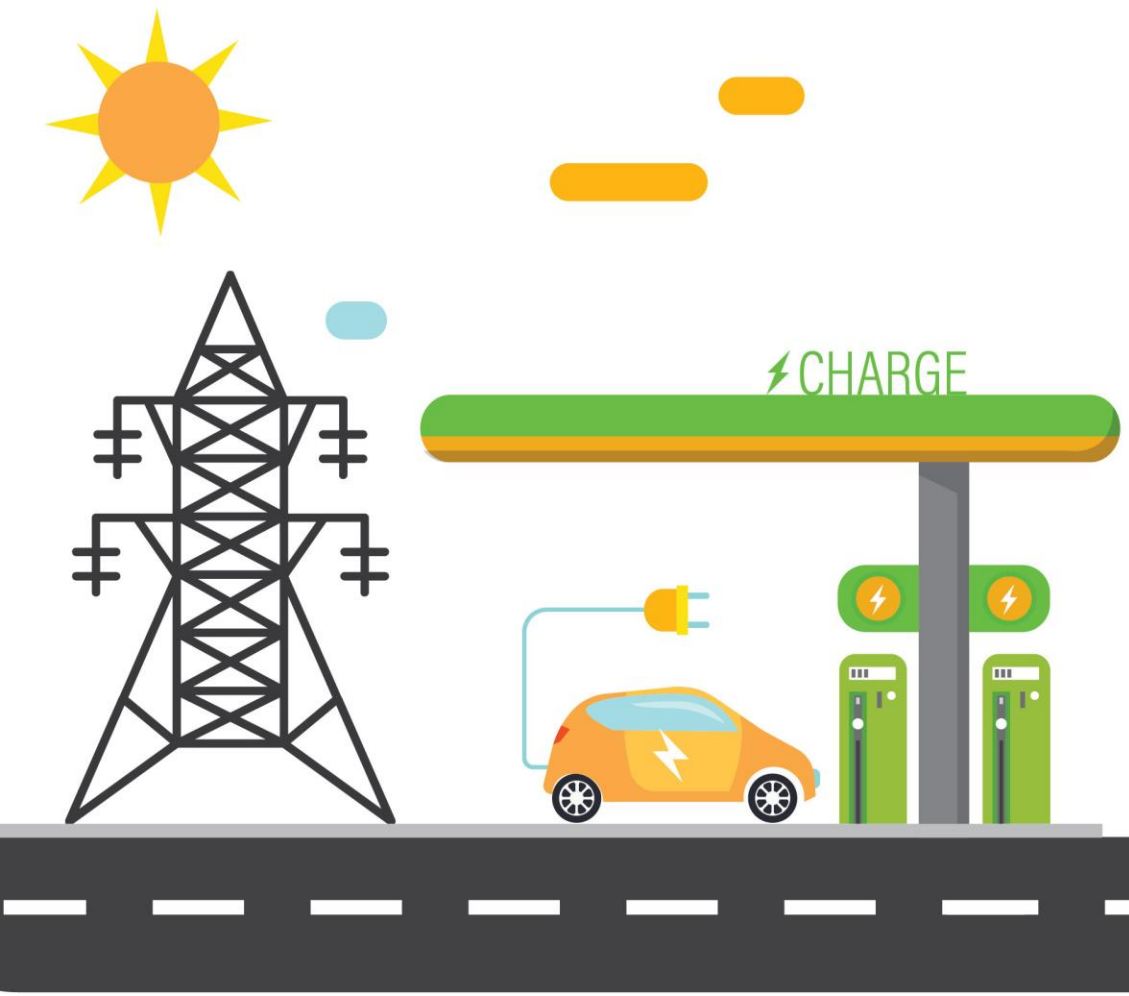

ELECTRIC MOBILITY FORUM

ENGAGE
Connecting Big Ideas To Action

Impact of Electric Vehicle (EV) Charging on the Local Grid

September 16, 2019 | 3:00 PM - 4:00 PM (IST)

WRI INDIA
ROSS CENTER

SHAKTI
SUSTAINABLE ENERGY FOUNDATION

Speakers

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german cooperation
DEUTSCHE ZUSAMMENARBEIT

Implemented by

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Agenda

- Power System Components
- Indian Electricity Distribution Network
- Key stakeholders' roles in power supply to EV context
- EV has potential to play very important role in futuristic power system
- Electric Vehicle Charging Technologies
- Challenges: Power Quality and Overloading & opportunity

Dr Indradip Mitra, GIZ

- Rationale Behind the EV Impact Study
- Objective: Study on the EV Charging Impact on Grid
- Overall Approach: Designed task & activities
- Expected Outcome: Recommendation

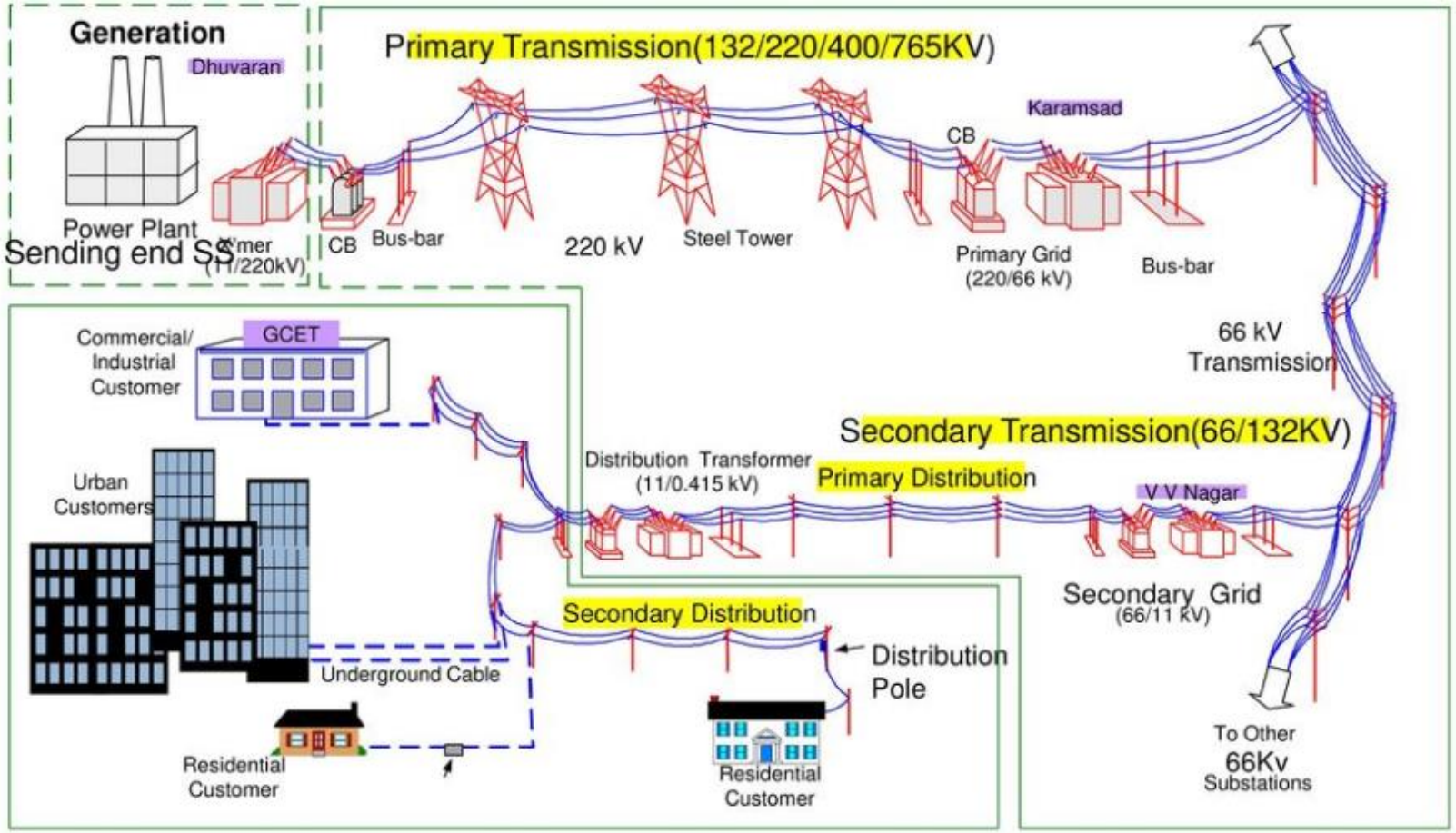
Mr Sudhanshu Mishra, GIZ

Agenda

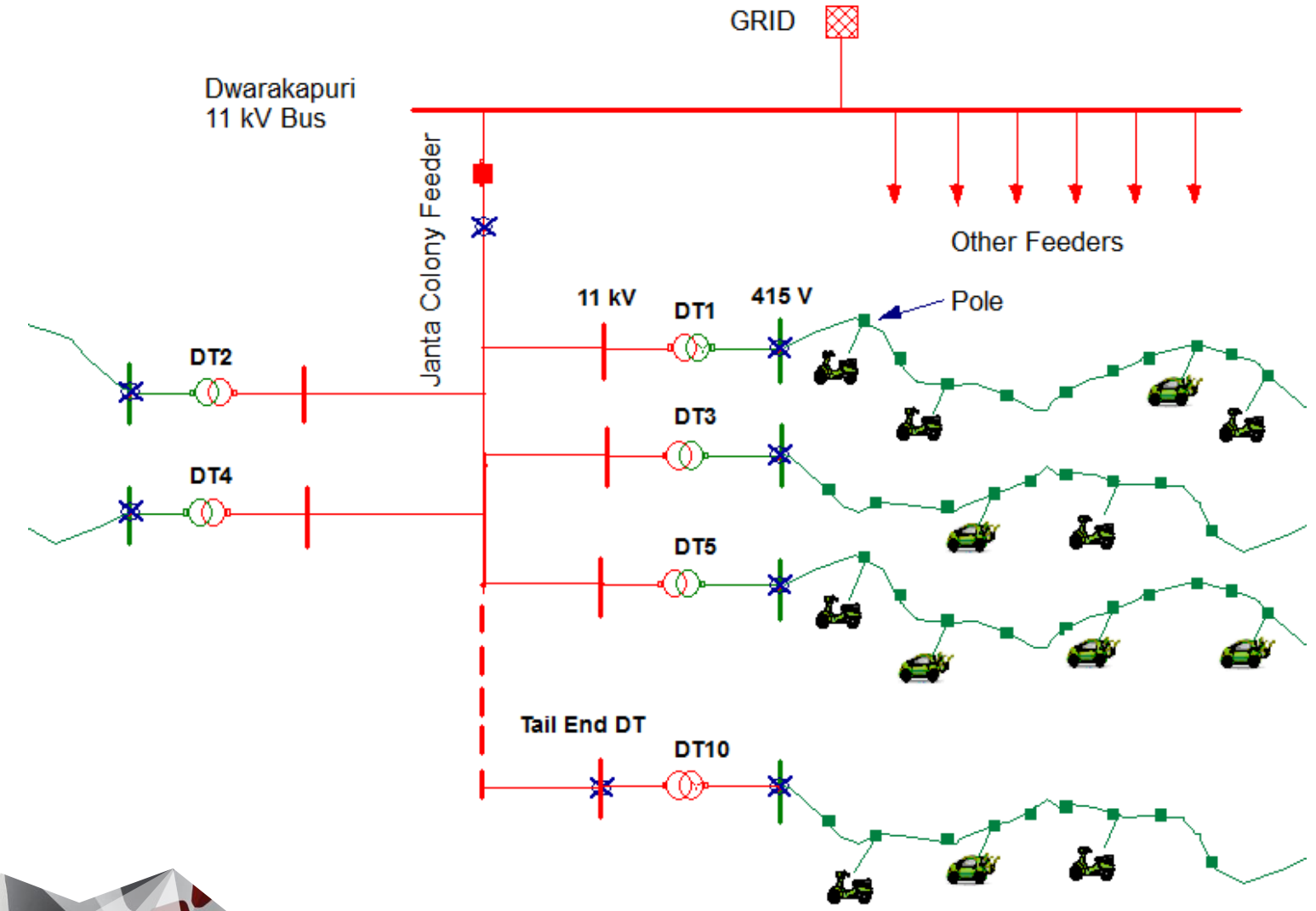
- Electric Vehicle Charging Technologies
- Charging Strategies for Mitigating Impact on the distribution grid
- Simulation methodology: Data collection, Feeder selection criteria
- Modelling Scenario Development for Sample feeders
- Simulation Results – Sample Feeders
- Conclusion & Recommendation

Dr Chandrasekhar Atla, PRDC

Power System components

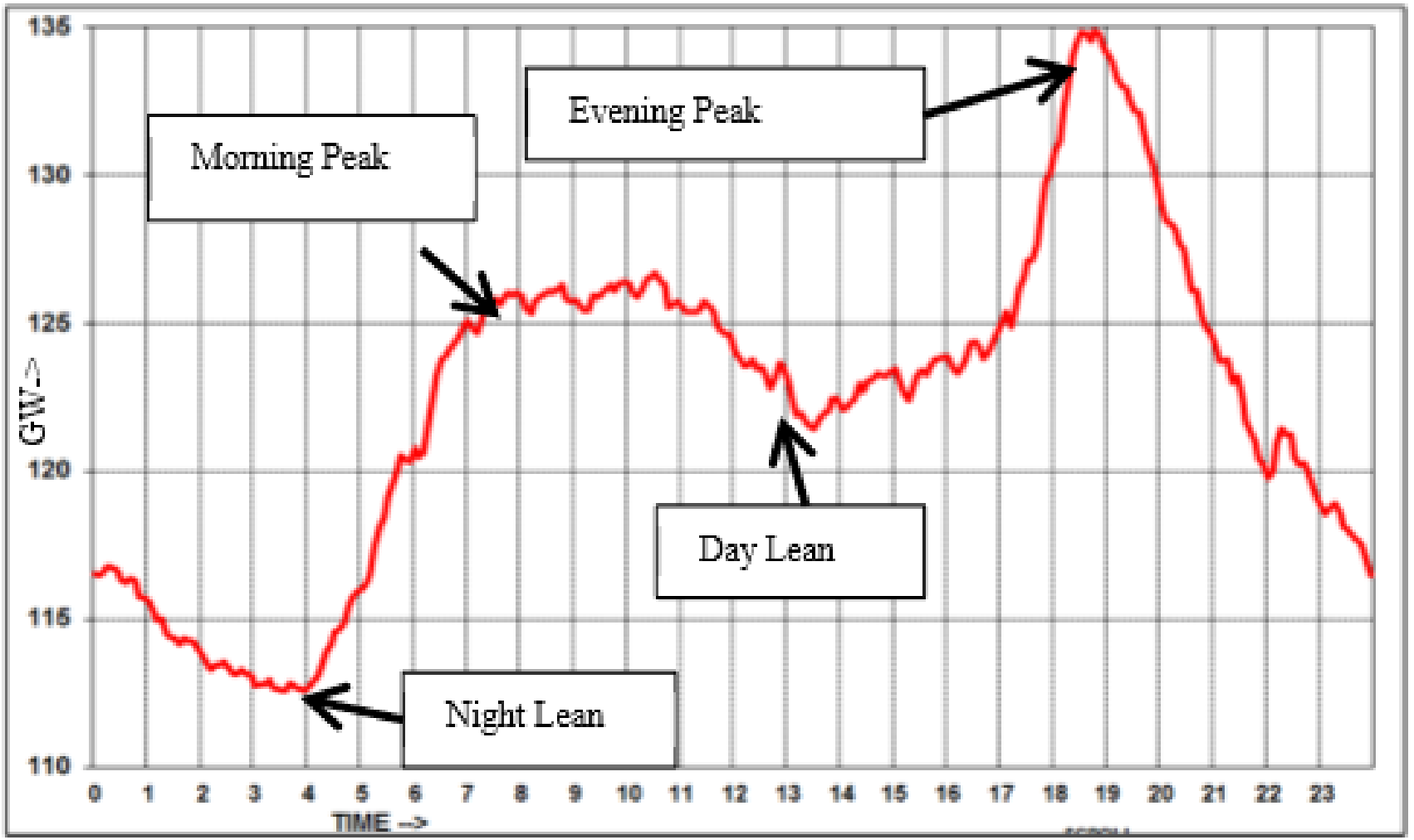


Indian Electricity Distribution Network



Source: BSES Yamuna Power Network

Typical Daily Electricity Demand Profile



Source: POSOCO

Key stakeholders' roles in power supply to EV context

EV user

- Role: EV and EVSE (EV Supply Equipment) utilization; potential provision of services through storage resources (e.g. ancillary services to system operator)
- Need: sufficient State of Charge to reach the destination; sufficient charging points (long distance travel); optimized battery utilization (wear & tear); interoperability between EV and EVSE in the whole country; remote communication with charging infrastructure

EVSEO (EV supply equipment operator)

- Role: EVSE management; EV charging process management
- Need: EVSE control and maintenance; identification, authorization, metering and payment for charging; communication interface to EV, Distribution System Operator, E-mobility Service Provider, and ESCO

Key stakeholders' roles in power supply to EV context

ESCO (energy service company)

- Role: delivery of energy to the EV; aggregation; delivering ancillary services to the grid
- Need: demand forecast; demand localization; aggregation facility;

Distribution system operator:

- Role: delivery of power and energy; grid planning and operation
- Need: demand forecast; demand localization; congestion management, maintaining power quality

Transmission System Operator:

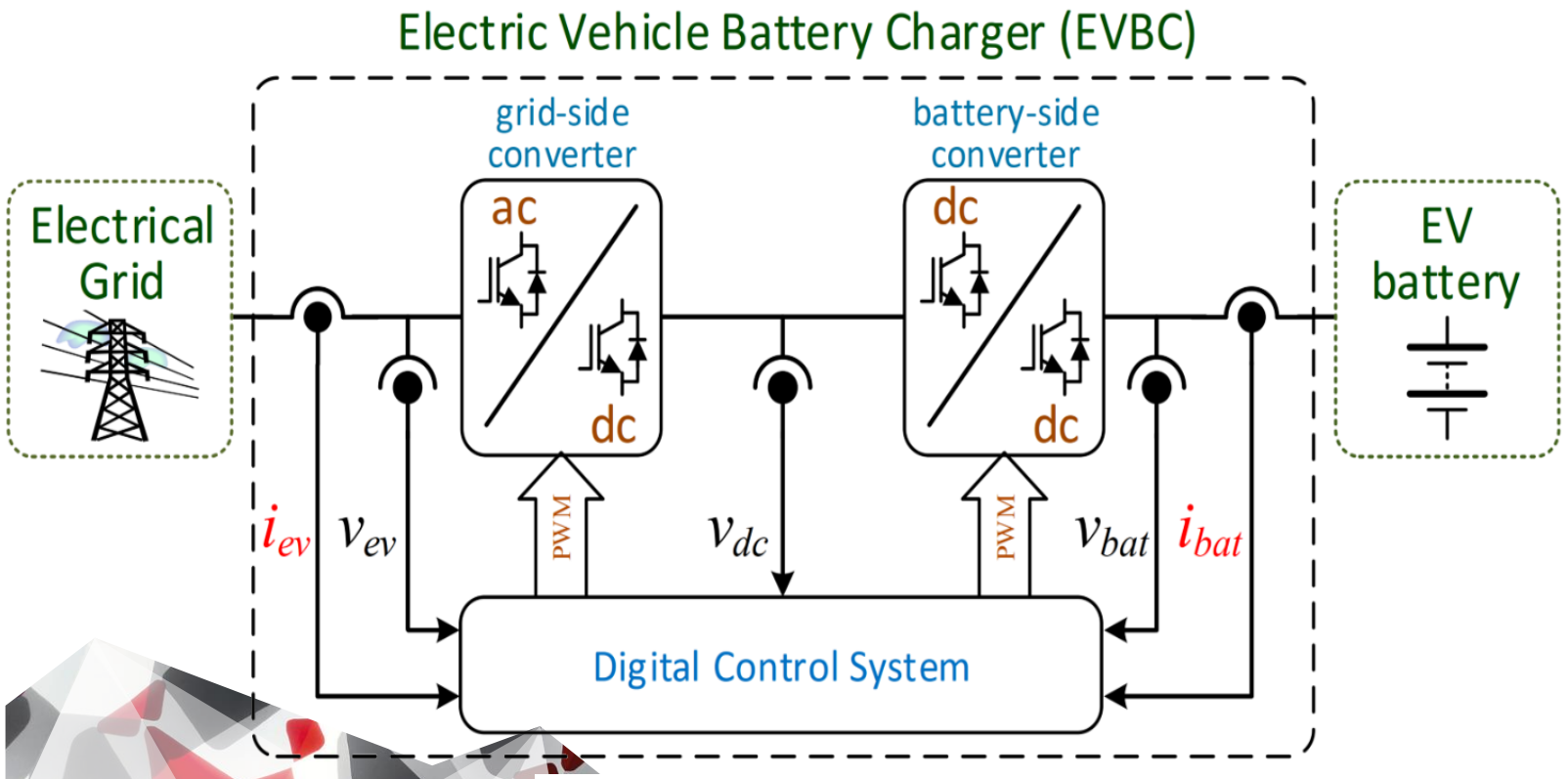
- Role: unit commitment; system balancing;
- Need: demand forecast; system ancillary services;

EV has potential to play very important role in futuristic power system

- Recent trend towards futuristic grid structure is inclined towards decentralized smaller generation powered by variable renewable energy like solar or wind resources.
- Such futuristic grid will have more focus on bi-directional power flow.
- Presently on a large electric power system the demand must be supplied by generation – loss included – very small amount of electrical storage.
- EVs can be viewed as not only loads but also as distributed energy storage devices.
- It is anticipated that EVs in the future with the Smart Grid to provide electrical energy demand shifting services such as reducing their charging rate or delivering electricity to the grid.
- EV infrastructure eco-system can provide load management as well as grid support services.

EV Battery Chargers: Principle of Operation

EV Battery Chargers (EVBC) for both on-board and off-board systems



Structure of EV Battery Charger (EVBC) with digital control system

On-board charger: Installed inside EV.

Off-board charger: Installed outside EV.

It consists of two power electronic converters: one at grid side and other at battery side and digital control system which is common to both converters.

The digital control system is responsible to generate gate pulses to turn the power electronics devices ON/OFF.

Challenges : Power Quality and Overloading

Component Overload

Thermal loading: To what extent component is normal and emergency ratings exceeded (number of occurrences, typically overload asset classes, duration and magnitudes).

Voltage: To what extent does EV loading adversely impact system voltage regulation. (Voltage excursions, regulator operations, voltage flicker, etc.).

Unbalance: Potential for disproportionate penetration on particular phase and results on system unbalance.

Losses: Impact on distribution system losses.

Power Quality

EV battery chargers use power electronic devices to convert AC to DC power. This conversion process can cause voltage and current harmonic distortion

The harmonics have impact on the distribution assets which reduces their life-span and also cause false tripping in the case of protection equipment. Majorly the following assets are affected the most:

- Transformers
- Power Cables
- Relays, Switchgear and Metering Equipment
- Capacitors

Opportunities for the Distribution Operators

- An increase in the amount of energy distributed could constitute an increase in the DISCOM revenues under some regulatory frameworks where revenues are not decoupled from energy delivered.
- Local voltage and reactive power control is possible by EV converters.
- EV charging can compensate for high vRE production during valley hours (typically at night), thus allowing DISCOMs to alleviate congestions and reduce or defer grid reinforcements.
- EVSE can communicate with a DISCOM control center and provide services such as load forecasting, thus facilitating operation.
- EV system may offer flexibility in short term power system operation
- Introduction of EV may help integrating vRE by charging when vRE production is high and discharging when low
- Need economic incentives and market design reform in Indian context

Rationale Behind the EV Impact Study

Grid Integration of Recharging Infrastructure in the Distribution networks

- Rapidly growing and gaining popularity of EVs will also usher lot of recharging infrastructure construction
- Significant adoption of (EVSE – Electric Vehicle Supply Equipment) is expected to connect with distribution network in coming years
  - *Government initiatives, Market conditions, and regulatory framework are also driving the EV market*
- These recharging infrastructure of various categories (fast, medium, & slow) will be connected the distribution network (LT as the case may be)
- Impact of variable distributed generation (in case rooftop solar PV) with inclusion of a dynamic active load from EVSE severely impact the network

Rationale Behind the EV Impact Study

Impact on Distribution Grid

- Low Vs High Penetration of EVs

Impact of uncontrolled EV charging

- Major congestion problems in already heavily loaded grids,
- Low voltage problems in predominantly radial networks,
- Increase in peak load,
- Load imbalances between phases in LV grids.

Ways to accommodate the presence of EVs in the distribution grids

- To reinforce the existing power infrastructures and plan new networks
- To develop and implement enhanced EV charging management strategies in the distribution networks along with Demand Response functionalities

Need of Simulation Studies

- Load Flow Studies
- Dynamic Studies
- Power Quality Studies

Objective: Study on the EV Charging Impact on Grid

Study on the Grid Integration Aspects

Objectives

- What would be the impact of EV charging over distribution network?
- To identify and evaluate major technical challenges with integrating large share of EVSE systems in the distribution system
- It also aims to evaluate different technical solutions to address these challenges and help distribution licensee(s) to prepare their networks augmentation
- It shall also prepare a methodological approach for conducting similar analysis based studies in other parts of the distribution network across India

Overall Approach for conducting Study

- GIZ joined hands with BSES Yamuna Power Limited to study to conduct the study
- Renowned experts in the field of grid integration were engaged to conduct the study
- The results shall be disseminated to other distribution licensees to help replicate the findings

Task divided in to three work packages time-wise overlapping activities

- Work Package 1: Preparatory
- Work Package 2: Measurement, collection, and assessment of data
- Work Package 3: Simulation and Recommendation

Expected Outcomes

Recommendation on

- ✓ Major technical challenges and solutions with integrating different category of EV charging along the identified feeders (***static & dynamic simulation***)
- ✓ Charging Infrastructure hosting capacities without any technical intervention along the identified feeders
- ✓ Preferred locations would be optimal from an electrical network point of view within the analyzed feeder areas

- The Grid Dynamic Report (GDR) - anticipated load from EV charging and estimate the requirement for network augmentation to accommodate incremental load

- Suggest further approaches, scope of further studies which may be conducted in future for better and smooth integration of EVSE along with distribution generation in the distribution network

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