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# Utility Grid Integration of EVs and V2G: Impact on Electricity Networks Course

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## Introduction:

Utility grid integration of EVs and V2G is the engineering practice of connecting electric vehicle charging, and vehicle-to-grid V2G export of stored battery energy, to electricity distribution networks without breaching thermal, voltage or protection limits. This one-week course is for distribution, planning, protection and charging infrastructure engineers, and each delegate leaves with a Feeder EV Hosting Capacity and V2G Integration Assessment. It is taught at practitioner level through a modelling build of load profiles, transformer loading and feeder voltage calculations, using ISO 15118-20, the vehicle-to-grid communication standard for bidirectional power transfer, together with IEEE 1547-2018 for interconnecting distributed energy resources.

## Course Objectives:

- Distinguish unmanaged, managed and bidirectional charging, and interpret how each changes peak demand and hosting capacity on a distribution feeder
- Compare ISO 15118-2 with ISO 15118-20 and OCPP 2.0.1 with OCPP 2.1, and select the protocol stack a bidirectional charging site requires
- Apply load forecasting and transformer loading calculations to estimate how many charge points a feeder can host before reinforcement
- Interpret voltage, harmonic and protection effects of V2G inverters and apply IEEE 1547-2018 functions such as volt-var control and ride-through
- Compare traditional network reinforcement with flexibility procurement from aggregated EV fleets, and justify the option with lower lifetime cost
- Justify a Feeder EV Hosting Capacity and V2G Integration Assessment with stated assumptions, limits and mitigation measures

## Target Audience:

- Distribution network engineers who operate low and medium voltage feeders and decide whether a new charging connection can be accepted
- Grid and investment planners who forecast demand growth and decide when transformers and feeders must be reinforced
- Power system and protection engineers who set relays and fuses and judge how bidirectional chargers change fault behaviour
- EV charging infrastructure engineers who design charging hubs and depots and choose the charger, protocol and connection capacity
- Energy regulation and connection policy specialists who review interconnection rules and decide what V2G export a network can allow
- Utility network operations specialists who dispatch flexibility and decide when managed charging signals are sent to aggregators

## Course Outline:

### Day 1: EV Charging Load, Network Impact and Current-State Assessment

- Vehicle-Grid Integration Terminology: V1G, V2G, V2H and V2B Defined for Networks
- AC vs DC Charging: IEC 61851 Modes and Connection Power Levels Compared
- EV Charging Load Profiles: Residential, Workplace, Fleet Depot and Public Hub Patterns
- Coincidence and Diversity Factors: Estimating Aggregate After-Diversity Maximum Demand
- Current-State Feeder Assessment: Transformer Ratings, Spare Capacity and Load Data Gaps

### Day 2: Bidirectional Charging Standards, Protocols and Interconnection Architecture

- ISO 15118-2 vs ISO 15118-20: Plug and Charge and Bidirectional Power Transfer
- OCPP 2.0.1 vs OCPP 2.1: Charger-to-Backend Smart Charging and V2X Control
- CCS and CHAdeMO Bidirectional Capability: Connector Architecture and Onboard vs Offboard Inverters
- IEEE 1547-2018 Interconnection Functions: Volt-Var, Frequency-Watt and Ride-Through Settings
- UL 1741 SB and IEEE 2030.5: Inverter Certification Testing and Utility Communication Interfaces

### Day 3: Hosting Capacity, Managed Charging and Network Calculations

- EV Hosting Capacity Analysis: Thermal, Voltage and Protection Limits on a Feeder
- Unmanaged vs Managed Charging: Peak Shifting Effect on Distribution Transformer Loading
- Distribution Transformer Ageing Calculation: Hot-Spot Temperature and Loss-of-Life Under EV Load
- Feeder Voltage Drop Calculation: Load Flow Modelling of Clustered Charging Sites
- Smart Charging Control Modes: Scheduled vs Dynamic Setpoints Under ISO 15118-20

### Day 4: Power Quality, Protection, Aggregation and Network Risk

- Voltage Rise vs Voltage Drop: V2G Export Effects on Low Voltage Feeders
- Charger Harmonic Emissions: Measurement, Cumulative Distortion and Filtering Options for Feeders
- Protection Coordination With Bidirectional Chargers: Fault Contribution, Islanding and Reverse Power Flow
- EV Aggregation and Virtual Power Plants: Flexibility Services, Demand Response and Dispatch
- Time-of-Use vs Dynamic Network Tariffs: Effect on Charging Behaviour and Rebound Peaks

### Day 5: Modelling Build: Feeder EV Hosting Capacity and V2G Integration Assessment

- Feeder Model Build: Load Profiles, Transformer Data and Charging Scenario Inputs
- Scenario Modelling: Unmanaged, Managed and V2G Penetration Cases on One Feeder
- Network Reinforcement vs Flexibility Procurement: Lifetime Cost Comparison for Constrained Feeders
- Multi-Sector Case Study: Bus Depot, Logistics Fleet and Residential Estate Connections
- Feeder EV Hosting Capacity and V2G Integration Assessment: Limits, Mitigations and Actions

## Skills You Will Gain:

- EV Hosting Capacity Analysis
- After-Diversity Maximum Demand Estimation
- Transformer Loss-of-Life Calculation
- Feeder Load Flow Modelling
- Bidirectional Charging Protocol Selection
- Smart Inverter Settings Configuration
- Harmonic Distortion Assessment
- Flexibility Service Design

## Why Attend This Course:

- From approving charging connections on nameplate ratings alone to calculating hosting capacity against thermal, voltage and protection limits
- From treating EVs as fixed new load to modelling managed charging and V2G export as controllable network resources
- From reinforcing transformers whenever a charging hub appears to comparing reinforcement cost with flexibility from aggregated fleets
- From fragmented connection studies to a Feeder EV Hosting Capacity and V2G Integration Assessment with clear limits and mitigations

## Conclusion:

Electric vehicles become a network asset rather than a network problem when their charging is forecast, controlled and, where bidirectional chargers allow, used to export energy back to the feeder. The course makes three distinctions clear: unmanaged versus managed charging and the effect on transformer loading; ISO 15118-2 versus ISO 15118-20 for bidirectional control; and network reinforcement versus flexibility procurement. It suits engineers and specialists who calculate, connect and protect distribution networks and need practical methods for rising EV and V2G penetration.

## Frequently Asked Questions FAQ:

### What should delegates know before a utility grid integration of EVs and V2G course?

Delegates should understand basic power system concepts such as load flow, transformer ratings and voltage limits. Bringing anonymised feeder data, load profiles or a pending charging connection request helps, because these are used in the modelling build that produces the hosting capacity assessment.

### How does a utility grid integration of EVs and V2G course differ from a charging station installation course?

Installation courses focus on wiring, mounting and commissioning chargers. This course looks from the network side: hosting capacity, transformer and feeder loading, power quality, protection, interconnection standards and flexibility services, so engineers can decide what the distribution grid can accept.

### Can V2G and managed charging increase the EV hosting capacity of a distribution feeder?

Yes. Shifting charging away from the evening peak and exporting stored energy at peak times lowers transformer and feeder loading, so a feeder can host more vehicles before reinforcement. The size of the gain depends on control reliability, customer participation and local network limits.

### What does a delegate take back to work after a utility grid integration of EVs and V2G course?

Each delegate takes back a Feeder EV Hosting Capacity and V2G Integration Assessment covering load scenarios, transformer and voltage calculations, protocol and inverter requirements, and a costed choice between reinforcement and flexibility, ready to adapt to real connection decisions.