CIGRE Study committe C1

PROPOSAL FOR THE CREATION OF A NEW WORKING GROUP

WG C1.57

NAME OF THE CONVENOR
Mauri Giuseppe (ITALY)

TITLE
Charging Infrastructures for EV including Heavy Duty EV: Sustainable Integration into the Power System

THE WG APPLIES TO DISTRIBUTION NETWORKS: YES

ENERGY TRANSITION
1 / Storage
3 / Digitalization
4 / Sustainability and Climate Change
5 / Grids and Flexibility
7 / Consumers, Prosumers and Electrical Vehicles
8 / Sector Integration

POTENTIAL BENEFIT OF WG WORK
1 / commercial, business, social, economic benefits
2 / potential interest from a wide range of stakeholders
4 / state-of-the-art or innovative solutions or directions

STRATEGIC DIRECTION
1 / The electrical power system of the future reinforcing the End-to-End nature of CIGRE: respond to speed of changes in the industry by preparing and disseminating state-ofthe-art technological advances
3 / Focus of the environment and sustainability (in case the WG shows a direct contribution to at least one SDG)

SUSTAINABLE DEVELOPMENT GOAL
7 / Affordable and clean energy
9 / Industry, innovation and infrastructure

BACKGROUND :
The global transition to cleaner energy systems is driving a rapid expansion in adopting electric vehicles (EVs). While pivotal for decarbonizing the transportation sector, this growth poses significant challenges and opportunities for power system planning, operation, and infrastructure development. The electric vehicle charging process is where sector coupling between the transport and energy sectors is cyber-physically realized, acting as a critical enabler for the successful development of both sectors.

Uncontrolled EV charging, with its dynamic and potentially high-power demand, introduces complexities in load management, grid flexibility, and energy storage integration. Effectively managing the charging process not only mitigates avoidable issues such as grid congestion and peak loads but also unlocks significant opportunities. “Smart” charging can support the integration of renewable energy generation by reshaping the power demand curve, improving system management in terms of ancillary services and grid congestion mitigation, and reducing both system costs and user costs realisng true win-win solutions.

Furthermore, the active role of end-users in managing their charging behaviors, when aligned with digitalization and advanced demand management strategies, can limit battery degradation and enable more effective resource allocation.

The development of a widespread and accessible charging infrastructure, addressing the needs of diverse stakeholders, alongside the widespread adoption of smart charging processes, currently represents a critical gap that must be bridged to align positive business cases with system benefits. The integration of EV charging infrastructure into power systems must also consider economic viability, regulatory compliance, environmental sustainability, and technological innovation. Successfully addressing these challenges is essential to supporting a resilient, efficient, and affordable energy transition that fully realizes the potential of electrified transportation.

PURPOSE / OBJECTIVE / BENEFIT OF THIS WORK :

This Working Group aims to provide guidance on integrating EV charging systems into the evolving power grid to enhance system flexibility, reliability, and sustainability. The objective is to evaluate widespread EV adoption's technical, economic, and operational impacts that need to be assessed also in transmission and distribution grid planning process and develop strategies to optimize grid interaction while mitigating potential risks. The anticipated benefits include improved system planning methodologies, increased stakeholder engagement, and actionable recommendations to accelerate the deployment of EV charging infrastructure while maintaining grid stability and affordability.

This work will support system operators, energy system planners, asset managers, and policymakers by identifying best practices, and innovative approaches, and enabling technologies to seamlessly integrate EV charging into the energy system, contributing substantially to the broader goals of the Energy Transition.

Scope:

The working group aims to investigate, report, provide insights and recommendations on:

1. **Analysis of current and emerging EV charging technologies and use cases:**
. Analysis of current EV charging interconnection requirements:Analyze their various use cases of EV charging and their requirements, including charging hubs, residential chargers, workplace chargers, depot chargers, and en-route chargers for heavy-duty vehicles.

2. **Assessment of charging load impact on grids**:
Review and analyze current and projected charging demand profiles for different transport segments, including light-duty and heavy-duty vehicles. Review and analyse methodologies of charging demand profile forecast. This will include an evaluation of peak load scenarios and their effects on system adequacy, grid stability and infrastructure investments. The analysis will focus on identifying potential challenges such as grid congestion, infrastructure capacity limitations, and the need for system adjustments to accommodate varying charging demand patterns. Analyze of using EV charging demand forecast in transmission and distribution grid development plans.

3. **Analysis of flexibility mechanisms:**
Explore the role of flexibility mechanisms such as demand response, and vehicle-to-grid technologies (V1G and V2G: Vehicle-to-Grid, Vehicle-to-Home, Vehicle-to-Building, Vehicle-to-X), in mitigating charging impacts on the power system. Analyze how these flexibility mechanisms can manage peak demand, enhance grid stability, and reduce infrastructure costs. Additionally, investigate how flexibility can be integrated intoa coordinated planning and development phases of the power and transport systems, to better respond to uncertainties and avoid costly retrofitting of infrastructure, ensuring a more sustainable and reliable system coupling.

4. **Review of methodologies for consistent EV charging deployment and integration with the power system:**
Review and analyze existing methodologies and tools for the deployment of public and private EV charging stations across various transport segments, considering grid integration requirements, and geographic, economic, and regulatory constraints. The analysis will explore how these methods align with the development of the electric grid infrastructure, ensuring that the expansion of charging stations is closely integrated with grid planning and upgrades. Furthermore, the study will investigate the emerging role of digital platforms and artificial intelligence (AI) in providing the neede data exchanges between system operators, aggregators, charging operators, EV owners.

5. **Economic analysis**:
Assess the Total Cost of Ownership (TCO) for different segments of vehicles and how this will drive the electrification process.

Assess the cost-benefit dynamics and impact of EV integration at various system levels. A key consideration will be the economic impact of grid extension required to support new charging stations, including how these balance the needs of EV users with the broader economic impact on grid users.

6. **Stakeholder Collaboration and Policy Recommendations**
Promote collaborative approaches to actively engage key stakeholders, including end-users, regulators, energy utilities, EV and battery manifacturers, and transport operators in the planning and deployment of EV charging infrastructure. Foster knowledge exchange among stakeholders to ensure that advancements in one sector complement and enhance progress in the other. Develop policy recommendations and strategies to address both technical and non-technical barriers,developent plans, guide planning methodologies to facilitate the seamless integration of large-scale EV charging systems while ensuring alignment with stakeholder needs.

7. **Best practices and innovation sharing**:

Document and analyze state-of-the-art practices and identify successful case studies, emerging technologies, and innovative methodologies that support the effective and consistent development of both recharging infrastructure and the electric grid.

Remarks:

This WG will liase strongly with C6, with a constant liasing expert, especially on EV (DER) requirements.The working group foresees liaisons with the following other working groups

- WG C6.40 (TB 954): Electric Vehicles as Distributed Energy Resource (DER) systems
- WG C6.42: Electric Transportation Energy Supply Systems
- WG C5.34: Summary of Current Uses of Electric Vehicle Charge/Discharge Flexibility in wholesale energy markets and reliable grid operations
- JWG C1.C4.36 Review of Large City & Metropolitan Area power system development trends taking into account new generation, grid and information technologies
- This WG will ask a liason member to SC D2 regarding data exchange: "Furthermore, the study will investigate the emerging role of digital platforms and artificial intelligence (AI) in providing the needed data exchanges between system operators, aggregators, charging operators, EV owners."

SCOPE :

The WG will focus on advancing the integration of electric vehicle charging systems with the electric power system to facilitate both sectors' smooth and sustainable development. It will analyze current and upcoming charging proccesses and devices, explore innovative approaches, and provide actionable guidance for overcoming technical, economic, and regulatory challenges associated with large-scale EV integration, considering the electrification of both light and heavy-duty transport segments. The WG will address critical aspects such as smart charging (V1G and V2G), flexibility mechanisms, economic impacts, stakeholder collaboration, and policy recommendations to ensure that the deployment of charging infrastructure complements and enhances the resilience and adaptability of power systems.

DELIVERABLES AND EVENTS

Deliverables Types

Annual progress and activity report to Study Committee
Electra report
Event
Future connections
Technical Brochure and Executive Summary in Electra
Tutorial
Webinar

Time schedule

Q1	2026	• Recruit members (National Committees, WiE, NGN)
Q1	2026	• Develop final work plan
Q2	2027	Tutorial & Webinar
Q4	2027	• Draft TB for Study Committee Review
Q1	2028	Final TB

APPROVAL BY TECHNICAL COUNCIL CHAIRMAN:

Rannveig S. J. Loken
December 16th, 2025