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EXECUTIVE SUMMARY

ePowerMove Deliverable D3.1 "*Design and Development of a Grid-Charging-RES*", focuses on the design of a multi-layer Vehicle-to-Grid (V2G) architecture that takes into account electric vehicle (EV) charging, local on-site renewable energy sources (RES) production, and EV user preferences. The proposed V2G architecture has been developed to enable coordination and data exchange between the solutions being developed within the ePowerMove project, including Distribution System Operator (DSO) control centre systems, new grid-level solutions from Task (T) 3.2.1, local controllers and equipment, Charging Point Operator (CPO) platforms, and EV owners.

The developed V2G architecture primarily emphasises data exchange flows while also considering energy flows between individual stakeholders. The architecture is not only theoretically descriptive; in its final section, the proposed V2G architecture is adapted to the specific design of the ePowerMove Use Cases (UCs).

In the first part of the deliverable, the literature on V2G system architectures is reviewed. Different scientific and technical sources are analysed, focusing on design methodologies, key findings, and identified gaps. Particular attention is given to assumptions and differences between the reviewed V2G system designs and the V2G system envisioned in the ePowerMove project.

Following the literature review, the ePowerMove V2G architecture design methodology is proposed. The methodology is structured to encompass all parts of the task and guide efficient V2G architecture development. A clear and structured path is described, starting from stakeholder identification and continuing through energy and data flow definition to the final step, where the general V2G architecture is adapted to the specific ePowerMove use cases. It should be noted that an Internal Milestone (IM) was conducted in Month 6 (M6) of the project (June 2025), during which initial data-exchange and functional requirements for each grid- and charging-level solution were investigated and defined. This milestone enabled early inputs from project solutions to be integrated into the V2G architecture development and ensured that individual solution requirements were considered.

With the methodology defined and inputs from the IM incorporated, the V2G architecture is introduced in Chapter 3, *Synergetic Framework for a Harmonised V2G System*. First, stakeholders are identified and their descriptions of activities (DoA) are defined. In addition to expected stakeholders such as the DSO, CPO, EV user, Electric Vehicle Supply Equipment (EVSE), and RES operators, the architecture introduces the Charging Site Leading Entity (CSLE). This entity is introduced to allow the V2G architecture to be adapted to specific system needs. The architecture foresees that either the CPO or the E-Mobility Service Provider (EMSP) may assume the role of the CSLE, depending on the V2G system design. The DSO, retailer/aggregator, and EV user are also key stakeholders within the V2G architecture. The role of the CSLE is particularly important, as it must consider the requirements of all stakeholders: the DSO in terms of grid stability, the retailer/aggregator in terms of market participation, and the EV user in terms of charging needs and preferences.

In the next stage of the architecture design, a multi-layer structure is introduced. Three layers are defined:

- Local Power Supply Level,
- Charging Level, and
- Grid Level.

Within each layer, predefined stakeholders are arranged according to their DoA. Most stakeholders operate primarily within a single layer but remain connected to stakeholders across other layers, enabling interconnection and coordination throughout the V2G system.

In the following phase, energy and data flows are analysed. Energy flows, describing the movement of electricity within the V2G architecture, are introduced first. Compared to data flows, energy flows are relatively straightforward and less complex.

Data exchange in the V2G system is more complex and involve a greater number of connections. For each identified connection, data exchange requirements are defined, and Application Programming Interfaces (APIs) are developed to enable secure information exchange. For each connection, the following aspects are addressed:

- Types of data exchanged,
- Communication protocols and standards,
- Authorisation and verification mechanisms,
- Frequency of data exchange,
- Risks and cybersecurity considerations.

Following the definition of the general V2G architecture, the final part of the report presents its adaptation to the project's use cases. This adaptation provides input for future work in Work Package (WP) 3 and WP4, which will focus on the deployment of V2G solutions at the project pilot sites. In addition to adapting the architecture, local stakeholders are identified and the current state of APIs is documented. This enables mutual understanding, alignment, and collaboration between use cases and helps avoid isolated development of V2G systems at individual pilot sites. Furthermore, plans and options for future API development are outlined to support alignment between use cases and encourage knowledge sharing for efficient system and API development at the project level.

In conclusion, D3.1 establishes a common architectural and methodological foundation for V2G system development within the ePowerMove project. By aligning stakeholders, defining energy and data exchange structures, and adapting the architecture to the project's use cases, the report supports coordinated system development and ensures interoperability across solutions and pilot sites. This foundation will guide subsequent technical development, integration, and demonstration activities throughout the remainder of the project.