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D6.2: Social and Socio-Economic Impact Assessment

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1. Executive Summary

Deliverable D6.2 presents the combined **Economic Assessment** (EA) and **Social Impact Assessment** (SIA) of the Vehicle-Grid Integration (VGI) strategies developed within the XL-Connect project and constitutes the main output of Task 6.4. Together with the **environmental profiling of Task 6.3** (D6.3), it **completes** the economic and social dimensions of the **Life Cycle Sustainability Assessment** (LCSA) perspective adopted by WP6.

The two assessments are organized around **three structural levels of the system**, the charging infrastructure, the EV battery, and the use phase energy exchange, and are developed on a harmonized set of scenarios spanning uncontrolled charging (baseline), smart unidirectional charging (V1G) and bidirectional operation at increasing intensity (V2G Low, Medium and High). The EA follows a conventional Life Cycle Costing (LCC) approach compliant with ISO 15686-5:2017, carried out at the system level on a reference 100 kWp installation and expressed as a Net Present Value over a 15-year horizon. The SIA follows the Social Life Cycle Assessment (S-LCA) framework of the UNEP/SETAC 2020 Guidelines and ISO 14075:2024 and, since it relies on generic country-sector data from the PSILCA v4 database, takes the operational form of a social hot spot analysis covering the Workers and Local Community stakeholder categories across the five social themes prescribed by the Description of Work (health and safety, transparency, job creation, working conditions, and well-being).

On the **economic side**, the life cycle cost of the reference 100 kWp installation is strongly dominated by the up-front capital investment: the charging infrastructure accounts for about 56% of the discounted LCC and the EV batteries for a further 32%, leaving the recurrent use phase charging cost at 10-12%. The two controlled strategies reduce the annual charging cost by 19,7% (V1G) and 21,9% (V2G) relative to uncontrolled charging, but, owing to this CAPEX dominance, these savings translate into only a 2,4% and 2,7% reduction of the total life cycle cost respectively. V1G and V2G turn out to be economically very close to each other, the modest V2G advantage reflecting an Energy Management System that exercises bidirectional flexibility selectively in order to limit battery ageing. The economic value of controlled and bidirectional charging is therefore clear on the energy bill yet limited on the whole-life balance.

On the **social side**, the cradle-to-gate analysis of the NMC battery concentrates the social risk on the Workers stakeholder category (about 2.320 medium-risk hours per kg of battery, roughly five times the Local Community figure). The dominant supply-chain hot spots are the cell and battery assembly stages, while Local Community risk is driven almost entirely by mineral extraction. When the result is translated to the use phase (per kWh delivered to the vehicle), the number of battery packs required over the vehicle service life becomes the decisive factor: the high participation V2G configuration (V2G High), whose accelerated cycling ageing requires a third battery pack, carries a social risk 1,5 times higher than all the other configurations, uniformly across every indicator and both stakeholder categories.

Read jointly, the economic and social findings converge on a single message. Smart charging and moderate bidirectional services (V1G, V2G Low and V2G Medium) capture the operational benefit of VGI without requiring an additional battery, and therefore without aggravating either the life cycle cost structure or the social risk profile of the baseline. Deep bidirectional operation (V2G High), by contrast, offers diminishing whole life economic returns while imposing a quantifiable social penalty linked to the extra battery production. Accelerated battery ageing is thus the common driver that connects the economic and the social dimensions of the VGI trade-off. These conclusions, together with the methodological caveats inherent to a qualitative system level economic evaluation and a generic data hot spot analysis, provide the inputs for the deployment recommendations to be consolidated in D6.5.

Keywords: Life Cycle Costing; Social Life Cycle Assessment; social hot spot analysis; Vehicle-to-Grid; Vehicle-Grid Integration; EV battery; PSILCA; Life Cycle Sustainability Assessment.