

Powering the Clean Energy Transition: The Strategic Role of Bidirectional V2X Interfaces

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Moving toward Net Zero Carbon Society by 2050, the energy market is facing the transition to a massive generation from non-programmable renewable energy sources (RES). The highly fluctuating and intermittent behaviour of RES, together with the progressive loss of power system inertia due to increasing RES integration, highlights the need for energy storage systems as a pivotal source of flexibility.

In this context, the rapid growth of Battery Electric Vehicles (BEVs) offers a unique opportunity: by acting as distributed and flexible energy storage, BEVs position Vehicle-to-X (V2X) technology as a critical catalyst for the green energy transition. By enabling bidirectional energy exchange between BEVs and the grid or electric users, V2X solutions can significantly reduce the requirement for large scale stationary storage systems investments. Specifically, V2X unlocks an extensive portfolio of services for Transmission and Distribution System Operators (TSO/DSO) through Vehicle-to-Grid (V2G), as well as for end-users via Vehicle-to-Building (V2B), Vehicle-to-Home (V2H), and Vehicle-to-Load (V2L) applications. V2X technology provides dual benefits: it accelerates transportation decarbonization and enhances grid resilience, facilitating RES higher penetration.

From an economic perspective, V2X allows industrial operators to capitalize on energy arbitrage and ancillary service markets. Simultaneously, it empowers EV owners to lower operational costs through incentives and optimized self-consumption of local renewable generation. Despite its potential, widespread adoption remains hindered by techno-economic hurdles - such as accelerated battery degradation and scarcity of bidirectional charging infrastructure - alongside complex regulatory and social challenges.

This Special Issue aims to disseminate novel and original research addressing the impact of BEV integration within RES-dominated grids and future energy systems

The topics of the session include, but are not limited to:

- **V2X techno-economic analysis**
- **Control and power management strategies including BEVs**
- **Smart grids and micro-grids including BEVs bidirectional interface**
- **Advanced modelling approaches and experimental activities on V2X concept**
- **System modelling and integration**
- **Analysis of battery performance and degradation rate in V2X operating modes**

