



Artificial intelligence for V2X energy management

D1.3.1 | PUBLIC OUTPUT SUMMARY

Design approach based on the May 2025 report

Purpose and contribution

V4Grid examines how artificial intelligence and machine learning can help coordinate electric vehicles with household demand, building consumption and renewable electricity generation. A connected vehicle may offer energy flexibility, but its availability changes and its primary purpose remains transport. Decisions about charging and discharging must therefore consider both energy opportunities and the next journey.

Deliverable D1.3.1 brings together forecasting, simulation of vehicle use and energy optimisation. Its contribution is a design framework for connecting these functions in vehicle-to-everything (V2X) applications. It reviews methods and proposes development directions; it does not establish measured savings or validated performance in operational deployment.

Applications covered

Application	Purpose of intelligent management
Vehicle to home	Coordinate household consumption, local generation and vehicle energy while preserving mobility.
Vehicle to building	Coordinate several vehicles with building demand, shared power limits and different departure needs.
Price responsive V2G	Explore charging and discharging in response to electricity prices within operating constraints.
Aggregated V2G	Assess how several resources could respond to external flexibility needs.

Smart one-way charging is a related starting point because it changes when electricity is consumed. Bidirectional charging adds the possibility of returning energy. The design considers both capabilities without assuming that every vehicle, charger or market arrangement supports every application.

Three distinct modelling tasks

A forecast estimates future conditions, such as solar output or electricity demand. A simulation explores plausible situations, including uncertain vehicle presence and charging needs. An optimisation method selects actions according to objectives and limits. Keeping these functions distinct makes their contribution and their evidence requirements easier to understand.



D1.3.1 | *Methods and interpretation*

Methods and development approach

Energy forecasts draw on historical observations and relevant weather or calendar information. The report reviews statistical approaches, conventional machine learning and neural networks. Method selection depends on data quality, the forecasting task and the need to interpret the result. Greater model complexity does not itself establish better decisions.

Vehicle availability introduces a different uncertainty. Charging records may reveal patterns across a group, but cannot establish an individual driver's plans. Simulated arrival, connection and energy-demand scenarios help assess strategies during development. In operation, current vehicle and charger status and available user input remain necessary.

The design reviews mathematical optimisation, approaches that account for uncertainty and search-based methods. It also considers rule-based control and repeated replanning as observations change. Reinforcement learning is identified as a development direction: a controller learns from the consequences of actions in an environment, with simulation supporting the exploration of different conditions before practical use.

The quality of the development environment matters. A strategy trained in one setting may require adaptation elsewhere. Transfer learning can help reuse experience for related tasks, but local generation, demand and vehicle patterns still need assessment. Missing or inconsistent observations must be addressed before they can provide dependable evidence.

Evaluation and public value

Forecasting should be assessed on later observations that were not used for training, preserving the order of time so that future information cannot influence earlier predictions. Control strategies need comparison with suitable reference methods and assessment against user and equipment requirements. Simulation supports repeatable comparisons, while observations at real sites are needed to establish practical relevance.

The intended benefits are better use of renewable electricity, lower demand peaks and improved coordination of flexible resources. These remain objectives to evaluate. The design report provides a basis for implementation, integration and assessment; this summary does not infer achievements after the source reporting period.

How this public summary was prepared

This document condenses the supplied D1.3.1 public brief and reorganises its concepts for a general audience. It retains the distinction between forecasts, simulations and control, together with the design-stage status. Datasets, mathematical formulations, model configurations, training procedures and proprietary implementation details are excluded.

Source basis: V4Grid D1.3.1 Public Brief, based on Design report of AI and ML approaches to V2X modelling, May 2025, Chapters A–E. This is a public summary, not the complete technical deliverable.