Electric Heavy Goods Vehicles

V2X Innovation programme: bi-directional charging demonstrations

Kaasai Services Ltd 2026

Authors/Acknowledgements

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Views expressed in this report are those of the researcher and not necessarily those of the UK Government.



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Summary

The Electric Heavy Goods Vehicles project was funded as part of the V2X Innovation programme: bi-directional charging demonstrations, which was part of the Net Zero Innovation Portfolio. The programme was run by Innovate UK on behalf of the Department for Energy Security and Net Zero. The funded project demonstrations concluded in September 2025.

Project overview

This project demonstrated that heavy-duty electric fleet vehicles can deliver commercially meaningful energy flexibility when bidirectional charging is combined with intelligent software control. The trial provided the UK's first operational evidence that V2X can materially improve the economics of heavy-duty fleet electrification by unlocking value from existing, unused battery capacity.

The trial was conducted at Islington Council's Waste and Recycling Centre using two electric refuse collection vehicles (eRCVs) converted to Vehicle-to-Grid (V2G), a one megawatt bidirectional charging system, and an AI native data and asset control platform. It was explicitly designed to reflect real commercial conditions: vehicles followed normal duty cycles, frontline services were prioritised at all times, and flexibility was delivered only where it could be accessed without compromising operational readiness.

The core outcome of the project is that electric heavy goods vehicles when V2G enabled and integrated with a smart AI data and asset control platform built for infrastructure and energy management, can outperform both diesel vehicles and unmanaged electric fleets on a total cost of ownership basis, creating a credible commercial incentive for wider fleet transition.

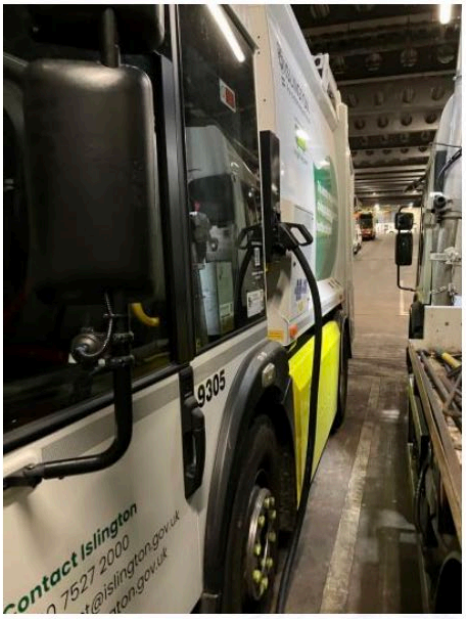
What was demonstrated

The project demonstrated that heavy-duty electric vehicles can be integrated into live municipal operations and operated as controllable, bidirectional energy assets without disrupting service delivery.

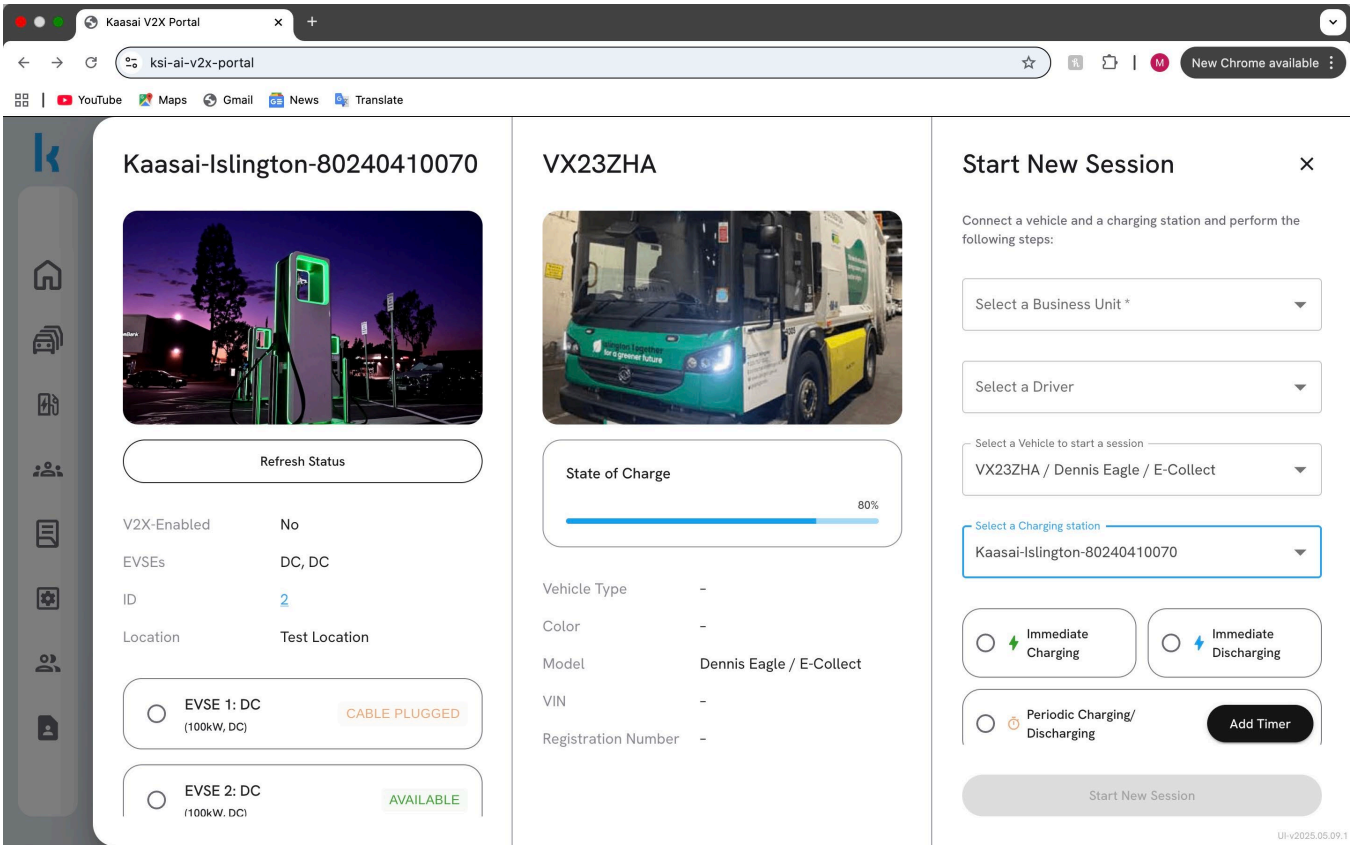
Bidirectional charging was deployed under software control, enabling remote and automated charging and discharging within defined operational constraints. Vehicles remained fully available for daily refuse collection duties, confirming that flexibility can be delivered as a secondary commercial function layered onto front line fleet operations.

This establishes that V2X for heavy-duty fleets is operationally viable, deployable in real depot environments and commercially beneficial.





Electric refuse collection vehicles at Islington Council's Waste and Recycling Centre connected to the bidirectional charging system during the Vehicle-to-Grid trial.



Cloud platform for remote discharge and charge control and optimisation.

What type of flexibility was delivered

The trial delivered behind-the-meter, intraday energy flexibility, characterised by:

Location:

- Primarily behind-the-meter at a fleet depot, with indicative export value used to inform future grid-facing participation.

Direction and service:

- Flexible import (demand shifting): High-power vehicle charging was shifted away from peak-price and peak-demand periods, reducing energy costs and exposure to site constraints.
- Controlled export: Short-duration discharge from vehicle batteries during defined depot dwell windows, using explicit power and state-of-charge limits, ensuring that the vehicles were compliant for operations requirements.

Timescale:

- Intraday (minutes to hours), aligned with predictable return-to-depot patterns rather than continuous availability.

Analysis of live operational data showed that vehicles consistently returned to depot with 30–40% usable battery headroom above minimum operational state-of-charge thresholds. This headroom was repeatable, operationally unused, and could be accessed for flexibility without compromising vehicle readiness.

The project provides evidence that predictable fleet operations can deliver repeatable, low-risk intraday flexibility, which is directly monetisable through energy cost optimisation and, when aggregated, suitable for participation in wider flexibility markets.

Commercial impact and scale

Under baseline trial operation, each vehicle generated approximately £1,800 per year in indicative flexibility value, derived from observed discharge behaviour and real-world price signals.

Modelling grounded in observed duty cycles and state-of-charge envelopes shows that:

- Data and AI led optimisation materially improves flexibility value, primarily by improving the timing of charging and discharge rather than increasing energy throughput;
- Annual per-vehicle value can increase conservatively to approximately £2,500–£3,300 under optimised operation;
- Over a 15-year vehicle life, this equates to approximately £35,000–£55,000 per vehicle in combined energy cost reduction and V2X value.

When incorporated into a full Total Cost of Ownership (TCO) assessment, electric refuse collection vehicles managed through intelligent charging and V2X achieved a forecasted 42% lower lifetime TCO than diesel equivalents, under conservative assumptions and excluding additional upside such as carbon revenues.

This finding is commercially significant: it demonstrates that flexibility is not an ancillary benefit, but a primary mechanism for closing and reversing the cost gap that has historically slowed heavy-duty fleet electrification.

Relevance for transition and replication

Heavy-duty fleets are constrained by long asset lifetimes, fixed capital budgets and risk-averse procurement cycles. The trial shows that flexibility-enabled electrification does not require early asset replacement or operational compromise. Instead, value can be unlocked incrementally, aligned with natural fleet replacement cycles and existing depot operations.

The main barriers to scaling identified were systemic rather than technical.

- Grid export approval timelines and uncertainty.
- Limited availability of market-ready bidirectional heavy vehicles and chargers.
- Minimum aggregated capacity thresholds for access to lucrative flexibility markets.

These barriers affect speed of scale, not viability. The project demonstrates that once vehicles and infrastructure are in place, data and AI software platform enabled flexibility provides a repeatable commercial upside, strengthening investment confidence and encouraging wider transition.

Key learning for government and policy

The key learning from this project is that energy flexibility is a decisive commercial enabler for heavy-duty fleet electrification, but only when it is operationally sound, AI and data software platform controlled and aligned with real fleet behaviour.

For government, this indicates that accelerating transition requires not only vehicle electrification support, but coordinated policy across grid connection processes, flexibility market access and standards maturity. Reducing friction in these areas would enable fleet

operators to capture flexibility value and unlock private investment without increasing operational risk or requiring additional vehicle subsidy.

Conclusion

This project demonstrates that heavy-duty V2X delivers practical, intraday energy flexibility with direct commercial value. When combined with intelligent data and software control, this flexibility materially improves the business case for electric heavy-duty fleets, enabling them to outperform diesel and unmanaged electric alternatives on a total cost of ownership basis.

The findings provide a clear signal to fleet operators, investors and policymakers: treating electric fleets as flexible energy assets is a credible and scalable pathway to accelerating heavy-duty transport decarbonisation in the UK.

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