Future Fleet Alpha

UKRI End of Phase Review

01/09/2026

Agenda

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Project Overview

Project Partners • Project Background

Project Partners

UK Power Networks — Delivering your electricity	Electricity distributor delivering power to 8.5 million homes and businesses across the East of England, London, and the South-East.
Baringa	Are a consulting partner to global utilities and energy companies, supporting strategic planning through to transformation implementation.
Catapult Energy Systems	Facilitates collaboration between the energy and transport sectors. Bringing knowledge and understanding of transport decarbonisation alongside wider energy sector challenges and emerging demand patterns.
Maritime	One of the largest privately owned logistics companies in the UK specialising in Container Transport and Full Load Distribution. The company owns and operates nine rail terminals across the UK and is operating a significant fleet of electric Heavy Goods Vehicles (eHGV's) alongside a comprehensive national charging network.
voltloader — CHARGED FOR TOMORROW	Launched in 2023, Voltloader is the UK's first all-electric HGV transport service working alongside its own highly utilised network of depot-based chargers.
VOLTEMPO™	Voltempo's vision and mission is to decarbonisation of commercial transport through electrification and to accelerate the adoption and optimisation of electric freight solutions.

Definitions: HGV's = Heavy Goods Vehicles

Project Background

Problem

Siloed decarbonisation of the logistics industry risks excessively straining electricity networks with clustered loads which will increase costs for operators and society.

Context: Decarbonising the logistics industry will be challenging due to the diversity of journeys, operators, and freight types, combined with high customer expectations, tight margins and the relative recent introduction of eHGVs.

Networks

- Lack detailed knowledge of how, when, and where operators will decarbonise
- Difficult to efficiently plan network investment
- Risk of becoming a blocker to net zero with potential long connection timelines

Logistics Operators

- Unfamiliar with smart energy management opportunities
- Operational and commercial models do not consider grid impacts
- Face longer connection timescales, high connection costs & volatile charging costs

Society

- Lagging decarbonisation of freight and slow progress to net zero
- Risk of additional network charges and higher bills
- Highly congested local networks delay other demand projects

What Future Fleet Set Out to Achieve

Solution

Future Fleet aims to **bridge the gap between the transport sector and the energy system by developing a comprehensive framework to support heavy goods vehicle decarbonisation.** This includes smart energy management, flexible connections, behind-the-meter assets, operational flexibility, and coordinated access models.

Objectives

- Understand eHGV uptake archetypes for logistics operators
- Investigate the smart energy management opportunities for eHGV operators to minimise grid impact & costs
- Accelerate connection times and decarbonisation by exploring operational flexibility & coordinated business models with eHGV operators
- Map the network impact

Outputs

- Logistics decarbonisation framework
- Optimal business models for different logistics operator archetypes
- Optimal smart energy opportunities for different operator provider archetypes
- Geospatial network impact of main logistics decarbonisation options

Project Progress

Deliverables • Work Package Progress

Deliverables

Name	Description	Completed at Midpoint?
WP1	Project management	
D1.1.1	Project Kick-off	Yes
D1.2.1	Midpoint Report	Yes
D1.3.1	End of Phase materials and Show and Tell slides	
WP2	eHGV fleet charging archetypes	Yes
D2.1.1	Fleet and charging location archetype report	Yes
WP3	Smart energy management schemes and business models	Yes
D3.1.1	Smart energy schemes and business model options report	Yes
WP4	Grid impacts and business case	
D4.1.1	Geospatial grid impact model and methodology report	
D4.2.1	Energy system cost/benefit assessment model and report	
D4.2.2	Fleet operator TCO cost/benefit assessment model and report	
WP5	Future opportunities, trial requirements & stakeholder engagement	
D5.1.1	Trials protocol document	

Agreed Project Start Date:
01/02/2026

Agreed Project End Date:
30/09/2026

Project Delivery Window:
01/03/2026 - 01/09/2026

Definitions: TCO = Total Cost of Ownership, WP = Work Package

Project Specific Conditions

Condition	Description	Relevant WP	Addressed on Slides	Status
1	The Funding Party must not spend any SIF Funding until contracts are signed with the Project Partners.	1		Complete
2	The Funding Party must report on the financial contributions made to the Project as set out in its Application. Any financial contributions made over and above that stated in its Application should also be reported and included on the Innovation Funding Service (IFS).	1		Complete
3	The Funding Party must make reasonable endeavours to participate in all meetings related to the Project that they are invited to by Ofgem, UKRI and Department for Energy Security and Net Zero during the Alpha Phase.	1		Complete
4	The Project will be allowed a flexible start date and duration within the 8-month period from the date the Project Direction is issued. The Project must tell the monitoring officer the start date and end date of the Project.	1	8	Complete
5	Prior to the end of Phase meeting, the Funding Party must provide to the Monitoring Officer a stakeholder engagement plan setting out how the Project will engage with a wider range of relevant stakeholders beyond the core consortium. This must include planned engagement with stakeholders from the Zero Emission HGV and Infrastructure Demonstrator (ZEHID) programme and with local and regional planning bodies, including Regional Energy Strategic Plans (RESPs).	5	32 & 33	Complete
6	Prior to the end of Phase meeting, the Funding Party must provide to the Monitoring Officer an updated risk management summary addressing risks associated with data inputs, data quality, and data sources. This should set out mitigation measures and explain how data-related risks will be managed to ensure the Project can deliver its intended outputs in a timely manner.	2, 3 & 4	13 & 16	Complete
7	Prior to the end of Phase meeting, the Funding Party must provide to the Monitoring Officer: • a summary of how learning from relevant international case studies has informed the Project's approach. This should include specific examples of comparable freight electrification or charging hub operational models and a clear explanation of how this learning has influenced the Project's proposed solutions; • a dissemination summary setting out how key learning from the Project will be shared openly. This should include consideration of issues related to the provision, operation, and income distribution of electric HGV charging hubs, to support wider replication and competition.	5	31 & 34	Complete

Work Package 1: Project Management

Lead Partner: UK Power Networks

Activities and Deliverables

Project Mobilisation

- Collaboration agreement signed
- Timelines and work packages agreed
- Kick-off meeting co-ordinated

Mid-point review

- Review project progress & documentation
- Q1 presentation

End of Phase & closure

- Delivery and approval of all work packages
- Governance reporting complete
- Project Specific Conditions addressed and evidenced

Success will be that project is delivered on time and to budget while meeting reporting requirements, Project Conditions and ensuring that the knowledge generated is effectively disseminated.

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WP2: eHGV fleet charging archetypes

Lead Partner: Energy Systems Catapult

Leading the development of fleet and charging archetypes, building on Energy Systems Catapult's models developed during the eFREIGHT 2030 project funded via the ZEHID Programme.

Main activities include:

- Categorisation of fleet archetypes
- Understand fleet ownership models
- Develop duty cycle assumptions and translate into energy needs
- Capture energy management opportunities
- Develop charging facility archetypes
- Cross-reference fleet and charging archetypes

Deliverables:

D2.1.1: Fleet and charging location archetype report

Success will be that fleet and charging location archetypes are defined and tested with wider stakeholders and are suitable for use in Work Package 3.

Definitions: ZEHID = Zero Emission HGV and Infrastructure Demonstrations

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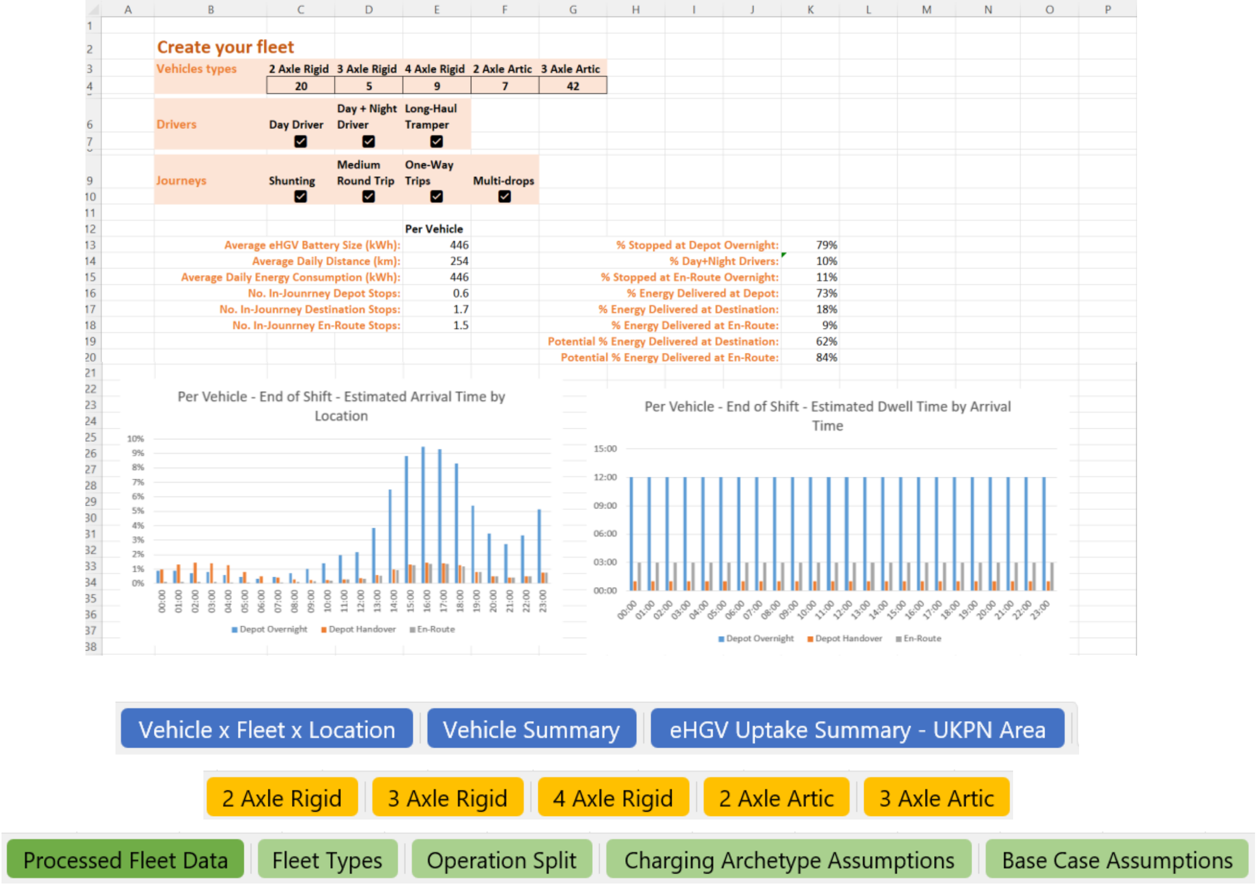
WP2: eHGV fleet charging archetypes

Outputs

Fleet and charging location archetype report

Fleet archetype outputs spreadsheet



WP2: eHGV fleet charging archetypes

Specific condition 6: Data Risk Management

WP2 highlighted several important data limitations and risks:

- The analysis relied on data provided by project partners, and therefore represented a limited sample of the wider HGV sector that will need to be expanded in future analysis
- Coverage of rigid HGVs was particularly limited within project partner fleets, despite these vehicles making up around 67% of the market
- The operational data also had limitations and therefore a number of informed assumptions were required around vehicle types, dwell times, charging opportunities and operational behaviour

Planned mitigations included relying more heavily on **eFREIGHT 2030 datasets**, supplemented by fleet operator workshops and validation to inform assumptions. For the Beta Phase, our report recommends expanding engagement with a more diverse range of fleet operators with discussions already underway, collecting more comprehensive and representative operational datasets, testing operational flexibility in practice, and specifically addressing the rigid HGV evidence gap. This would improve confidence in charging-demand forecasts and make the outputs more suitable for network planning applications.

WP3: Smart energy management schemes and business models

Lead Partner: Baringa

Assessing the potential for smart energy management strategies to support the integration of eHGV charging demand into the energy system, by reducing grid impacts and wider energy systems costs

Main activities include:

- Define a long-list of smart energy management opportunities that could reduce grid demand peaks and energy costs (e.g. charging dispersal, smart charging, use of DG and storage, I&C co-location, etc.)
- For prioritised schemes, assess use cases and benefits (grid demand peak, energy cost, carbon); set out required enablers (technical, business model, market, regulatory) and assess cost and complexity
- Investigate the impact of business model options that can provide charging access across the range of fleet archetypes, with a focus on affordable charging access for smaller fleets

Deliverables:

D3.1.1 Smart energy schemes and business model options report

Success will be delivering a report outlining smart energy schemes and business model options for affordable charging access across fleet types, including feasibility, scalability, and relevance to different fleet types.

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Definitions I&C = Industrial & Commercial, DG = Distributed Generation

WP3: Smart energy management schemes and business models

Aim: assesses how smart energy levers can reduce connection requirements and manage network constraints, informing the trial design and cost-benefit assessment

Inputs into WP3

WP2 archetypes
- Fleet and depot archetypes
- Charging demand and duty cycles

WP4 geospatial & network constraints context
- Connection constraints and locational clustering
- Depot size distribution

WP3: Smart Energy Levers & Business Model Assessment

Define smart energy levers
- Smart charging
- On-site energy
- Dispersed charging
- Shared sites / smart energy zones

Site-level economic modelling
- Representative depot archetypes
- Techno-economic comparison of scenarios
- Test connection and energy cost impacts

Business model assessment
- Value chains and commercial arrangements
- Enablers, barriers, and risks
- Applicability by archetype and location

WP3 outputs

Trial design requirements
- Priority levers and use cases
- Potential trial sites and models

Cost-benefit assessment
- Wider network, system, and societal impacts
- GB-level extrapolation

Methodology: We worked collaboratively with project partners to define the smart energy levers and integrate WP2 and WP4 outputs into the site-level economic modelling and business model assessments

WP3: Smart energy management schemes and business models

Project Specific Condition 6 – Data inputs risk management

Assessment of risks linked to data quality and availability

Data element	Primary source	Availability Risk	Quality Risk	Rational and mitigative measures
Fleet, vehicle and duty-cycle archetypes	Future Fleet WP2 outputs	Low	Low	Representative archetypes have been assumed for modelling, but real operations will vary by site-by-site. Mitigation is to test different depot sizes and duty-cycle sensitivities to assess how the economics may change for different fleet types.
Connection capex assumptions	UK Power Networks Connections team	Low	Medium	Connection costs are highly site-specific and do not scale linearly by £/MW. Illustrative assumptions were developed through discussions with the UK Power Networks Connections Team and used for sensitivity testing. The model has been built so different costs can be tested to assess the impact on the economic results.
Energy cost projections	Baringa energy price curves	Low	Low	Energy cost assumptions use Baringa proprietary projections, informed by pan-European energy market modelling and widely used in market analysis. Future prices remain sensitive to commodity prices, policy, network charges and market changes.
Asset cost and technical assumptions	Baringa market observations and modelling assumptions	Low	Low	BESS, solar and charger cost assumptions are based on values Baringa has observed across relevant infrastructure projects and asset sizes. Actual costs may vary by site, procurement route and delivery conditions, so assumptions are documented and can be sensitized, including replacement and O&M costs.
Flexibility and market revenue assumptions	Baringa flexibility price projections	Low	Medium	Capacity Market, Balancing Mechanism, ancillary services and export revenues are uncertain and depend on market access, technical capability and future market value. Mitigation is to treat these as upside sensitivities rather than the sole basis for the investment case.

Definitions: BESS = Battery Energy Storage System, O&M = Operation and Maintenance

WP4: Geospatial analysis and cost/benefit assessment

Lead Partner: Baringa, Support Partner: Energy Systems Catapult

Assessing the impact of eHGV charging demand on the network at a granular level, and modelling the potential opportunities to reduce energy system costs from a range of candidate smart energy management schemes

Main activities include:

- Develop geospatial model for allocation of eHGV charging demand against UK Power Networks' network model for impact assessments
- Assess smart energy schemes from WP3 and develop cost/benefit assessment model to bring together grid cost, energy cost, and carbon benefits from smart energy schemes
- Adapt ZEHID TCO model to assess impact of energy system benefits for fleet archetypes, including impact of business model options on CAPEX/OPEX requirements for access to charging, with a focus on smaller fleets

Deliverables:

- **D4.1.1** Geospatial grid impact model and methodology report
- **D4.2.1** Energy system cost/benefit assessment model and report
- **D4.2.2** Fleet operator TCO cost/benefit assessment model and report

Success will be an energy system cost-benefit assessment report, comparing smart energy scenarios to business-as-usual, and a fleet operator TCO cost-benefit report, quantifying financial impacts of different charging and infrastructure strategies.

WP4: Geospatial analysis and cost/benefit assessment

The model simulates eHGV journeys and charging behaviour to produce a geospatial demand layer for substation mapping, network impact assessment and the CBA

Modelling approach

- The model generates eHGV trips from origin-destination (OD) matrices and routes them across the UK Power Networks road network
- OD-matrices are built using a standard gravity model calibrated to WP2 archetypes
- Proxies used for eHGV activity are sizes of fleets and employment data. We assume that this scales well with relevant economic activity and therefore with eHGV needs
- Charging stops are allocated based on state of charge, vehicle range, stop intervals and the location of the stop in the journey
- Demand is aggregated by stop location to estimate charging stop counts and energy demand by archetype
- A bottom-up approach is used to capture depot clustering, major-route charging patterns and potential infrastructure gaps

Objectives

- Identify where eHGV charging demand may emerge across the UK Power Networks licence areas
- Estimate charging stop counts and energy demand by location and vehicle archetype
- Reflect differences between vehicle types based on the outputs of WP2
- Produce outputs that can be mapped to primary substations and used in network impact analysis
- Provide a transparent, reproducible evidence base for the CBA and trial prioritisation

Logic summary

OD demand is determined per vehicle archetype to simulate routed journeys, assign required charging stops, and aggregate outputs into a spatial demand layer for substation mapping and CBA purposes.

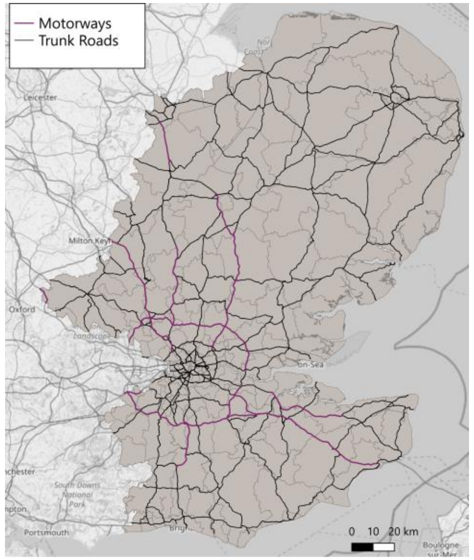
Definitions: OD = Origin-Destination, CBA = Cost Benefit Analysis

WP4: Geospatial analysis and cost/benefit assessment

The model produces a spatial charging demand layer showing where eHGV charging activity is likely to concentrate across UK Power Networks' licence areas

The geospatial model combines routed trips, candidate stop locations. and stop assignment logic to estimate spatial patterns of charging demand

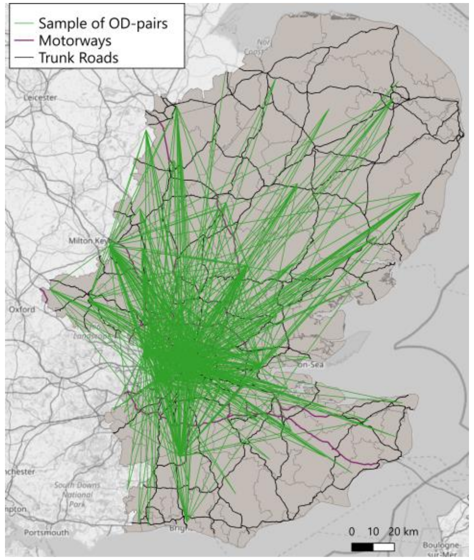
1. UKPN licence area and demand



Major road networks in UKPN licence area

- Covers UK Power Networks' three licence areas and uses zonal demand proxies to allocate eHGV trip activity
- Provides the geographic basis for routing, stop assignment and later substation mapping
- Routing uses configurable road-type preferences, with current defaults favouring major roads, motorways and trunk roads

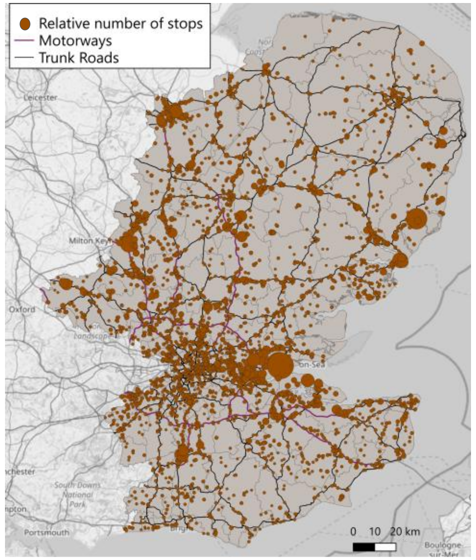
2. Trips between start and stop locations



Random selection of 700 trips (origin-destination pairs)

- Trips are generated from origin-destination matrices and land-use weighted origins / destinations. They can include external trips and existing hauliers' bases of operations
- Candidate stopping locations are drawn from a curated Fraunhofer ISE dataset
- Potential stops include fuelling stations, parking, rest areas, motels etc

3. Aggregated stops after routing



Circles scale with the number of stops summed for all archetypes

- Required charging stops are assigned using SoC, range and stop interval logic
- Relative number of stops per location does not depend strongly on the charging strategy
- Demand is aggregated by stop location and vehicle archetype to create a spatial demand layer

How to read the outputs

The maps illustrate spatial demand patterns rather than precise site forecasts. Circle size represents relative modelled stopping activity at each location.

Definitions: SoC = State of Charge

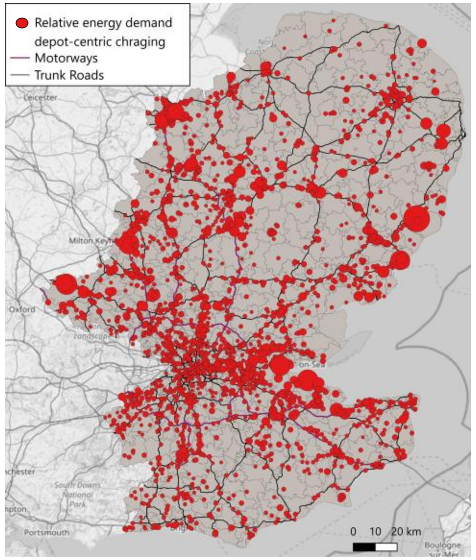
WP4: Geospatial analysis and cost/benefit assessment

Charging strategies shift modelled stops between depot, destination and mid-route locations

Circle size represents relative modelled energy demand resulting from charging activity at each stop location

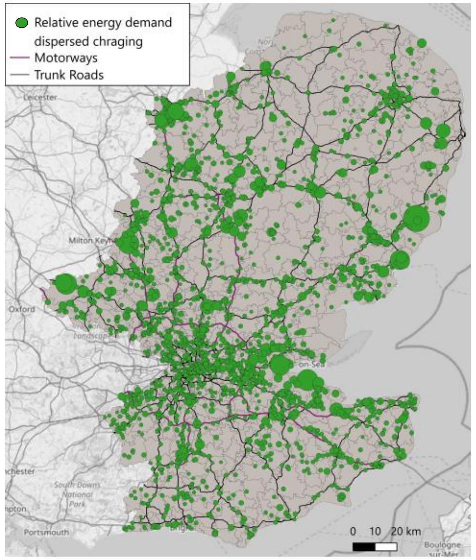
1. Depot-centric

Greater concentration of demand at depot / origin locations, with more limited reliance on mid-route charging



2. Dispersed

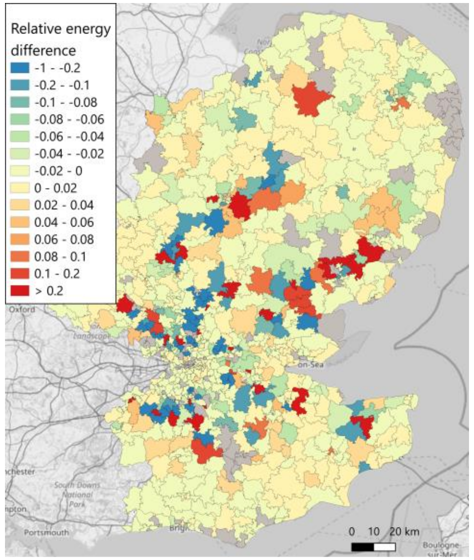
Greater use of mid-route / public charging locations, with lower concentration at depots



- The differences between the outcomes for the two charging strategies are limited when viewed at the licence area level, with stops being concentrated in built-up areas and along major roads
- The apparent lack of difference between charging strategies is a result of the average daily driven distance being smaller than the eHGVs range for the majority of trips/archetypes
- No charging stops are planned if the SoC does not require this as would lead to unnecessary operational inefficiencies and increase energy costs as home-depot charging is generally most cost-effective.

3. Differences

Although not immediately obvious from the preceding plots, differences do exist between charging strategies



- Significant changes in relative energy demand can occur when changing charging strategies. This signals the relevance of leveraging smart levers to reduce network impact
- An overall ‘cooling’ of the network is observed when moving from depot-centric to dispersed charging
- Results are indicative serve to demonstrate potential rather than need to be augmented with substation headroom to design smart interventions

WP4: Geospatial analysis and cost/benefit assessment

Translating geospatial outputs into annual depot growth

The geospatial model identifies where eHGV charging demand may concentrate. DFES provides the annual uptake pathway and is used to scale demand over time. These two inputs are key inputs for the network impact analysis as they allows us to assess where and when eHGV demand could trigger grid reinforcement

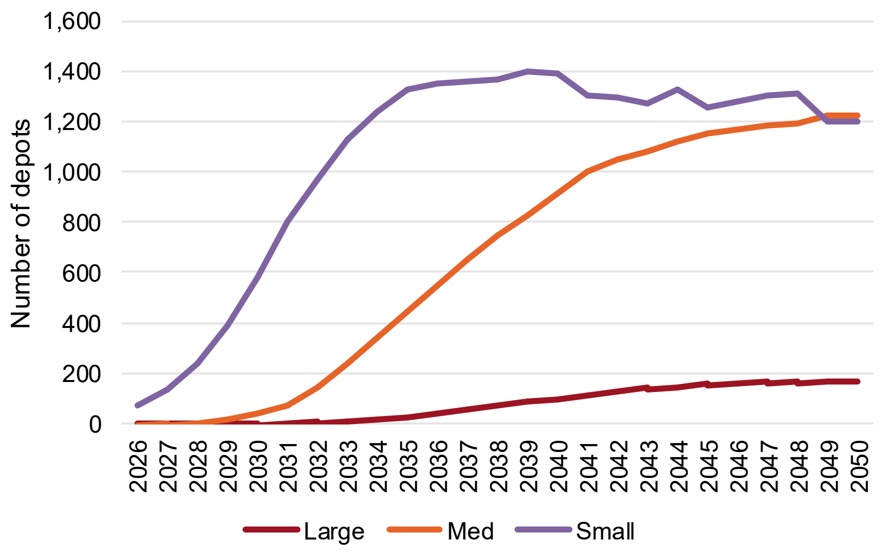
DFES scaling of geospatial outputs

- **Geospatial model** — Provides the spatial distribution of eHGV charging activity across UK Power Networks' licence areas
- **DFES trajectory** — DFES provides the annual eHGV uptake pathway, using the Holistic Transition scenario, to scale demand over time
- **Normalise and scale** — Location-level stop activity from the geospatial model is normalised to the DFES 2050 eHGV total, then scaled annually along the DFES trajectory
- **Spatial preservation** — Total uptake stays consistent with DFES while the geospatial pattern of demand is preserved as volumes grow

Annual depot reclassification

- **Fixed thresholds** — Each location is classified by daily stop count: Small ≤15, Medium >15–100, Large >100 stops
- **Annual reclassification** — Each location is re-evaluated every year against the same thresholds, so sites are not locked into a fixed size band
- **Dynamic depot evolution** — Locations can move between size bands as eHGV adoption grows, rather than being fixed in one category over time this enables depot growth to emerge naturally over time
- **WP3 & CBA linkage** — Size bands provide the bridge from location-level geospatial outputs to the WP3 depot archetypes used in the network impact analysis and CBA

Depot size curve



Why this matters

Scaling preserves the modelled spatial concentration of eHGV charging demand while aligning total uptake to the recognised DFES pathway. This creates an annual view of where depot-scale demand grows across UK Power Networks' licence areas, allowing the network impact analysis to assess when demand near primaries and substations may trigger reinforcement requirements and costs for the CBA.

Definitions: DFES = Distribution Future Energy Scenarios

WP4: Geospatial analysis and cost/benefit assessment

Project Specific Condition 6 – Data inputs risk management

Assessment of risks linked to data quality and availability

Data element	Primary source	Availability Risk	Quality Risk	Rational and mitigative measures
Road network	OpenStreetMap	Low	Low	Standard OpenStreetMap data that is stable and kept up to date. Model outcomes don't critically depend on 100% up-to-date road network. Updating the toad network that feeds into the model on a semi-annual basis is sufficient.
LAD / zone boundaries	UK Government Local Authority Districts Boundaries	Low	Low	Stable data set from a reputable source that can safely be assumed to be always available. Updating this on an annual basis suffices for the purpose of the modelling.
Employment totals	UK Government Business Register and Employment Survey	Low	Low	Data set from a reputable source that is updated annually. Recommended to use the same update frequency for the model.
Commercial / industrial land use	OpenStreetMap	Low	Medium	Standard OpenStreetMap data but more dynamic and with less strict classification rules and QA than for roads. Recommended to update quarterly and QA for misclassifications of land use.
Stops and amenities	Fraunhofer ISI data on Truck Parking Locations	Low	Medium	High-quality curated primary data set underpinning several scientific publications but no longer being updated so is updated with secondary data sets and OpenStreetMap date to keep current. As this is fast evolving space quarterly updates of secondary data sets are recommended.
Vehicle operator locations	UK Government OLBS Licence Reports	Low	Low	Stable data set from a reputable source that can safely be assumed to be always available. Updated weekly but for modelling purposes a quarterly update.
Vehicle archetypes	Future Fleet WP2 data for eHGV archetypes	Low	Medium	The used archetypes have been developed as part of this project and require validation in the Beta Phase, at which point there could be a need to update them.
Substation mapping	UK Power Networks	Low	Low	Core UK Power Networks data set that is kept up-to-date and made available.

Definitions: LAD = Local Authority District, QA = Quality Assurance, OLBS = Operator Licence Business System

WP4: CBA & Benefits

CBA Inputs:

- Primary demand and firm-capacity forecasts are combined with WP4 geospatial depot outputs and WP3 archetype charging profiles to assess reinforcement timing and costs across each charging scenario.
- Direct carbon benefits reflect the avoided diesel emissions from additional eHGVs smart solutions enabled to connect; indirect carbon benefits reflect changes in grid-electricity emissions from the modelled charging profiles.

Future Fleet CBA Principle:

- Smart charging and on-site energy solutions can reduce required connection capacity, lower energy costs and defer network reinforcement.

'Do nothing' Scenario (Baseline):

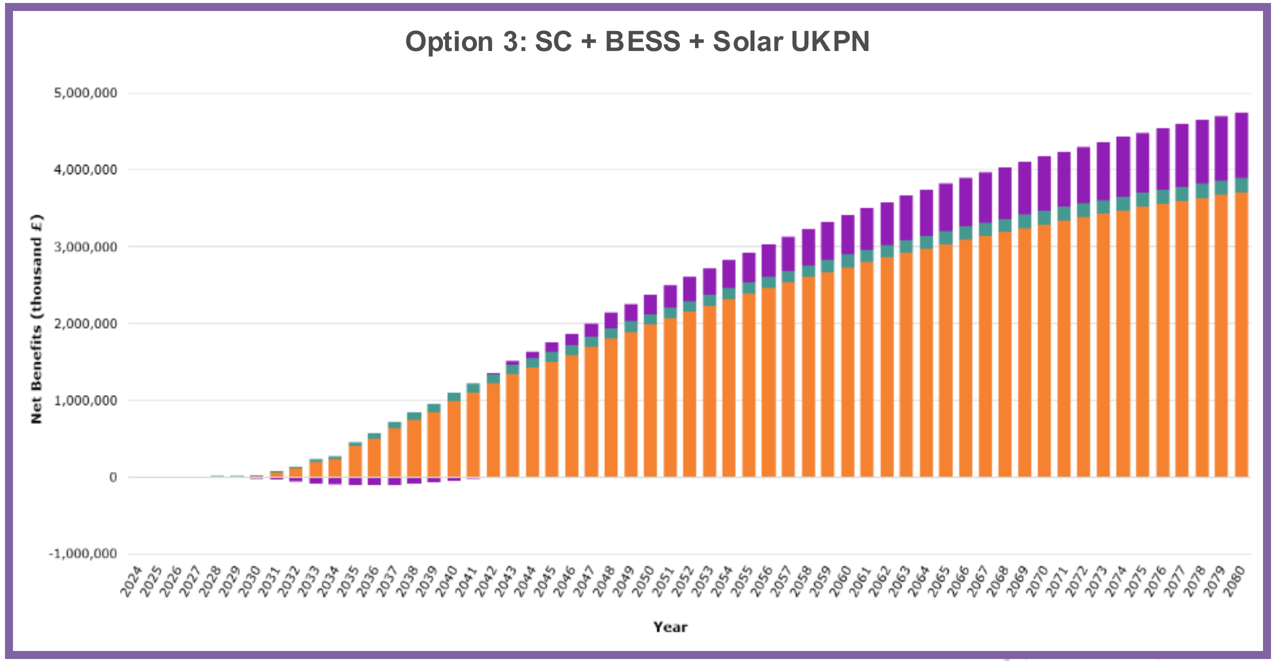
- Unmanaged charging may require larger grid connections, increasing costs and potentially delaying fleet electrification.

CBA Notes

- Option 1 – Smart Charging requires no additional assets and therefore avoids the incremental costs associated with options 2 and 3, this results in the highest quantified benefits.
- However, Options 2 and 3, which include BESS, can materially **reduce the maximum import capacity** a depot needs to request. This could enable a faster grid connection and deliver a potentially material benefit that is not quantified in the CBA, but is a key benefit for UK Power Networks.
- Option 3 delivers higher benefits than option 2 as it has greater energy cost savings and additional solar export revenues.
- Flexibility revenues are excluded from the CBA due to uncertainty in future market access and value, but could represent potential upside for BESS-equipped depots while supporting wider system flexibility and security.

Key Financial Benefits	Avoided network reinforcement cost
Key Societal Benefits	Energy cost saving
	BESS and Solar export Revenue streams unlocked
	Connection capex saving
Key Environmental Benefits	Reduced emissions

Lifetime Net:	Financial benefits	Environmental benefits	Societal benefits	Total Benefits
Option 1: SC UKPN	£3,122,739,773	£186,799,119	£2,557,223,231	£5,866,762,123
Option 2: SC + BESS UKPN	£3,680,424,321	£224,075,340	£766,437,694	£4,670,937,355
Option 3: SC + BESS + Solar UKPN	£3,709,358,900	£188,980,799	£851,653,622	£4,749,993,321



Definitions: SC = Smart Charging, BESS = Battery Energy Storage System

CATAPULT Energy Systems

WP4: Geospatial analysis and cost/benefit assessment

Fleet operator TCO cost/benefit assessment

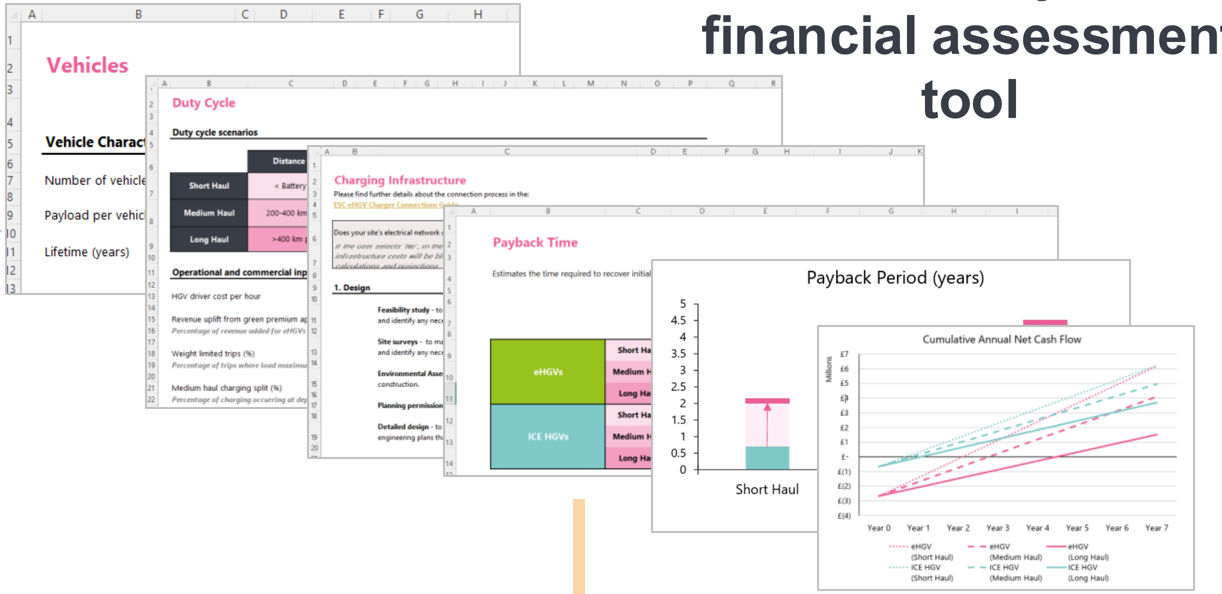
WP2 – Fleet archetypes

- Restricted – One-Man Bands (1 HGV)
- Restricted – SME (11 HGVs)
- Standard National – SME (14 HGVs)
- Standard International – SME (14 HGVs)
- Standard National – Large Fleets (83 HGVs)
- Standard International – Large Fleets (99 HGVs)

WP3 – Charging and business model options

1. Smart Charging
2. On-site Energy (Battery / Solar)
3. Charging in More Places
4. Shared Sites with Spare Capacity

Pre-feasibility eHGV financial assessment tool



WP4 – Output

- Assess impact of energy system benefits
- Assess impact of business model options – focusing on smaller fleets

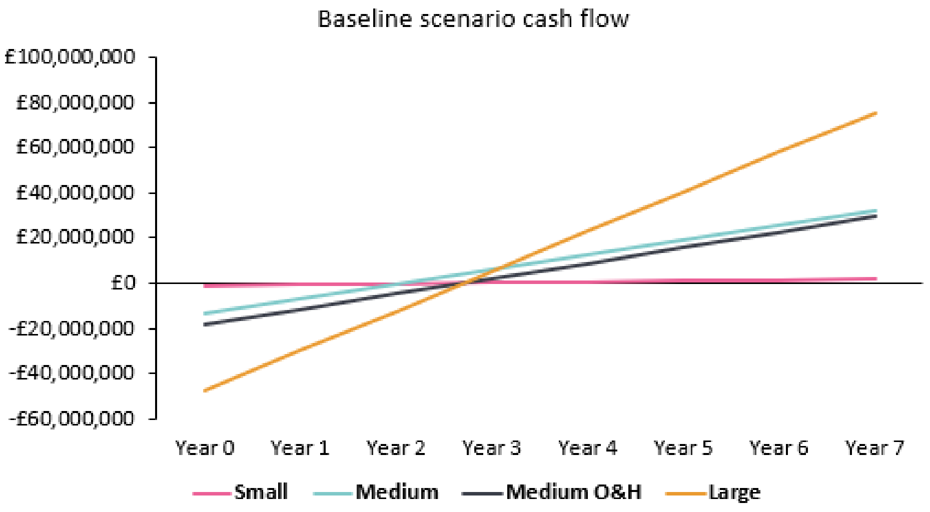
WP4: Geospatial analysis and cost/benefit assessment

Fleet/Depot archetypes

- Small
- Medium overnight
- Medium overnight & handover
- Large

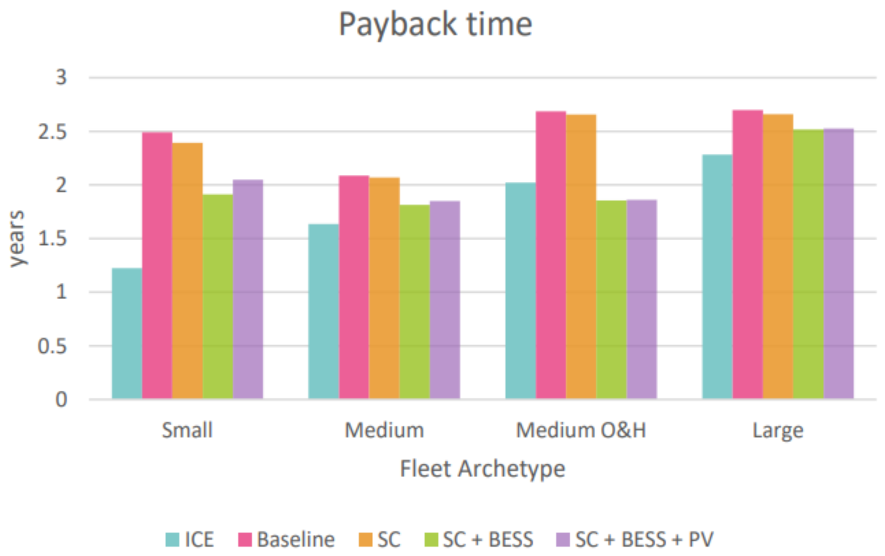
Scenarios

- Baseline
- Smart charging
- Smart charging + BESS
- Smart charging + BESS + PV



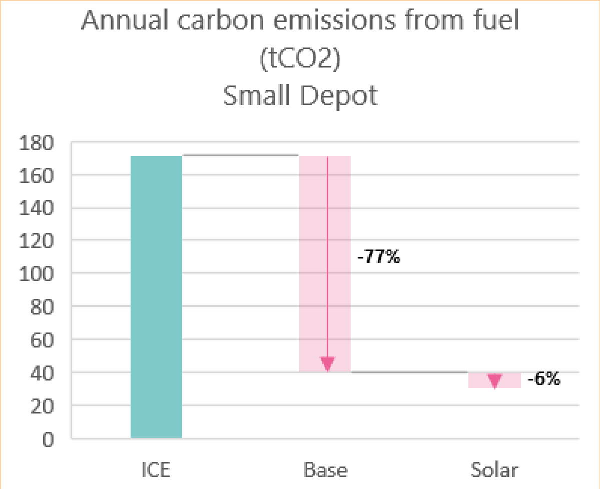
Key Findings

- Achieves payback within vehicle lifetime
- SC + BESS gives the shortest payback period
- Most pronounced improvement: Medium overnight & handover
- Leasing the vehicle can reduce payback time by 40-80%, but has further operational implications



Carbon Savings:

- Moving from ICE to eHGV brings a baseline of 74%-77% reduction
- Solar PV reduces emissions further (1%-6%) but does not show a direct payback reduction
- However, it improves longer-term energy cost stability, reducing grid exposure



Definitions: BESS = Battery Energy Storage System, PV = Photovoltaic, SC = Smart Charging, ICE = Internal Combustion Engine

WP5: Future opportunities, trial requirements & stakeholder engagement

Lead Partner: Voltempo, Engagement Support: UK Power Networks

Main activities include:

- Managing stakeholder engagement and dissemination initiatives
- Further develop the learnings from the preceding work packages, moving them from theoretical actions into a realistic trial, with a specific structure, timeline, defined outputs and closing point
- This business case should naturally flow into a Beta Phase proposal

Deliverables:

D5.1.1 Trials protocol document

Success will be the delivery of a real-world ready trial design, with a repeatable structure that will deliver the key information required by all stakeholders and the effective dissemination of the findings from the Alpha Phase.

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WP5: Future opportunities, trial requirements & stakeholder engagement

From Alpha Phase Evidence to a proposed Beta Phase Trial

WP5 has developed a proposed framework for further real-world testing, building on the findings from WP2-WP4

Alpha Phase Evidence

- WP2 – Fleet & Charging Archetypes
- WP3 – Smart Energy levers & business models
- WP4 – Grid impacts & cost-benefit analysis

Output: Evidence-based target list

WP5 Trial Protocol

- What could be tested
- Where trials could take place
- How performance could be measured
- Proposed decision points
- How findings could inform future option

Output: Proposed Beta Phase trial framework

Potential Beta Outputs

- Real-world operational evidence
- Evidence to inform future connection products
- Cost and investment insights
- Inputs to network tools
- Learning that could be applied more widely

Output: Beta Phase-ready proposition

Alpha Phase Evidence → Structured Trial decision → Evidence to support future decisions

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Trials Plan

		Stage Gate 1			Stage Gate 2			
Trial site 1 *Established eHGV fleet, managing smart charging*	**Mobilisation** Site selection, agreements, site specific trial design, monitoring equipment	◆	**Phase 0 and 1** Baseline + smart charging	**Phase 2** On-site energy	◆	**Phase 3** Shared capacity, **or map and redesign the connections process**		
Trial site 2 *Fleet is starting to electrify, charging unmanaged*		◆		**Mobilisation** Site selection, agreements, site specific trial design, monitoring equipment	◆	**Phase 0 and 1** Baseline + smart charging	**Phase 2** On-site energy	**Phase 3** Shared capacity, **or map and redesign the connections process**
Trial site 3 *Early stage or shared connection and V2G trial*		◆		**Mobilisation** Site selection, agreements, site specific trial design, monitoring equipment	◆	**Phase 0 and 1** Baseline + smart charging	**Phase 2** On-site energy	**Phase 3** Shared capacity, **or map and redesign the connections process**
Trial site x		◆			◆			V2G trial at one site
Supporting Work streams that input into the trials	**Engagement and data collection**							
	Shared capacity modelling				◆			
	V2G modelling				◆			
	National geospatial mapping and clustering analysis				◆			
	National archetype analysis				◆			

Definitions: V2G = Vehicle to Grid

WP5: Future opportunities, trial requirements & stakeholder engagement

Proposed Approach To Assessing Trial Evidence

The protocol proposes assessing both the quality of the trial evidence and the performance of each measure

1. Was the trial valid?

- Measurement period completed, covering a seasonal peak where relevant
- Telemetry and data availability threshold met
- Baseline rebuilt from historical data and accepted as sound or baseline measured over a period of time
- Required instrumentation in place at the site

2. Did the measure perform?

- Reduction in peak power drawn from the grid, against the stated comparison case
- Required fleet energy delivered within connection limits, with no charging unmet
- Reduction in the capacity of the site or coordinated group needs
- Cost change and modelled payback within the assumed period

Basis of Comparison

Smart charging vs the no-smart-charging baseline	On-site energy and shared capacity vs. the smart-charging case	Results reported per site, sensitivity ranges shown, modelled results labelled as modelled

WP5: Future opportunities, trial requirements & stakeholder engagement

What Each Trial Site Produces

Live Phase 0 and 1
Live at every site

Conditional Phase 2
Live where deliverable, otherwise modelled

Gate 2 Phase 3 and V2G
Modelled first, live subject to Stage Gate 2

Site 1
Established, managing smart charging

eHGV fleet running, charging already managed, historical records available

What it adds

Baseline rebuilt from real records, on a site already connected and established.

Produces

- Baseline rebuilt from historical records
- First connection type specification
- On-site energy results and investment case
- Phase closing reports and published dataset

Site 2
Electrifying, charging unmanaged

Fleet electrifying, charging not yet actively managed

What it adds

A different fleet type and driving pattern.

Produces

- Measured unmanaged baseline and dataset
- Updated connection type specification
- Transferability across different fleets and duty cycle and DNO regions.

Site 3
Early stage or shared connection

Early in transition, or a shared or third-party connected site and possible V2G trial

What it adds

A fleet at the start of its transition, and a setting where the connection is shared or owned by another party.

Produces

- Baseline for an early-stage fleet
- Shared and third-party connection evidence
- Evidence for energy hub commercial model
- Phase closing reports and published dataset
- Live V2G results, if not otherwise modelled.

WP5: Future opportunities, trial requirements & stakeholder engagement

Project Specific Condition 5: Stakeholder Engagement Plan

Stakeholder Engagement Completed during Alpha Phase

NESO National Energy System Operator

LOGISTICS UK

eFREIGHT 2030

Department for Transport

nationalgrid Electricity Distribution

Stakeholder Engagement Plan for Beta Phase

We will have a dedicated 'Stakeholder Engagement' Work Package in our Beta Phase proposal

Summary of Activities:

- Secured NGED's support to partner with us for the Beta Phase. Plan to partner with additional DNO, as well as engage with the other DNO's SFS teams during the Beta Phase
- We plan to expand the logistic operators we engage with and collect data from
- We have engaged with the NESO RESP's team in the Alpha Phase and will continue to engage with them
- We plan to continue engagement with governing bodies
- We plan to engage with the OEMs

Definitions: RESP = Regional Energy Strategic Plans, SFS = Strategic Forecasting System, OEM = Original Equipment Manufacturer

WP5: Future opportunities, trial requirements & stakeholder engagement

Project Specific Condition 5: Stakeholder Engagement Plan

Category	Engagement Purpose	Stakeholder Examples	Notes	Partner with connection
Government	Understand what are the regulatory barriers	OZEV, Department for Transport		UK Power Networks, Maritime, Voltempo, ESC
Logistics Operators	Validates archetypes, smart energy models & assumptions			(Logistics UK will Support)
OEM	Understand technology readiness and pipeline	DAF EV		Voltempo, UK Power Networks
Industry Body	Existing roadmaps for EV Trucks , policy, technology readiness, validation	The Society of Motor Manufacturers and Traders		UK Power Networks
EV charging infrastructure providers	Expand understand the technology landscape, charge point capabilities and interoperability with smart charging/flex	VEV		Maritime
Charging Plaza's	Helps to explore and understand shared/hub charging model			
System Operator	Inform them of the project	NESO	Focus on the RESP's team	UK Power Networks, Voltempo, ESC
Flexibility Aggregators/Suppliers	Understand flexibility market and how aggregated smart charging/fleet flexibility could be monetised or support grid services			Baringa
DNO's	• Validate findings and consider differences in their region we have not considered • Overall modelling approach and high level uses of data sources • Discuss results and see if it line up with what they are seeing	National Grid	Has Ports, high volume of operation, operates in Wales	UK Power Networks, Baringa, ESC, Voltempo
		Scottish and Southern Electricity Networks	Aligns with SCALE	UK Power Networks, Baringa
		SP Energy Networks	Aligns with SCALE, operates in Wales	UK Power Networks, Baringa, ESC, Voltempo
		Northern Powergrid, Electricity North West		UK Power Networks, Baringa
OEM	Understand technology readiness and pipeline			Voltempo

Definitions: OZEV = Office for Zero Emission Vehicles, SCALE = Scotland Charging to Accelerate Logistics Electrification

WP5: Future opportunities, trial requirements & stakeholder engagement

Project Specific Condition 7: International Case Studies

We reviewed international eHGV trials and applied their lessons to design a trial that tests real-world energy use, infrastructure needs and compatibility with a future freight fleet

Netherlands – Living Lab

Charging hubs

The Dutch Living Lab is studying six public and semi-public charging hubs to understand how electric truck charging works in real logistics environments. It considers charger design, grid capacity, site layout, vehicle movements and commercial viability. For Future Fleet, the project shows that electrification must be planned beyond individual vehicles. Charging demand, queuing, dwell times and fleet growth all need to be modelled so infrastructure remains practical and scalable as more eHGVs enter service.

USA · Run on Less

Electric depot

Run on Less Electric Depot examined battery-electric trucks carrying real freight from large operational depots. It gathered evidence on energy consumption, daily range, charging activity and the infrastructure needed to operate multiple vehicles. The programme demonstrates that future fleet readiness depends on more than advertised vehicle range. Route selection, dispatch decisions, charger availability, grid connections and infrastructure resilience must work together. Trials should therefore test multi-vehicle operations and peak charging demand, not just the performance of a single eHGV.

Australia · BluVein

Heavy haul

BluVein is developing a dynamic electric-power system for heavy mining and haulage vehicles operating on demanding, repetitive routes. Supplying power along the route could reduce reliance on very large onboard batteries, helping protect payload and vehicle productivity. For Future Fleet, BluVein illustrates the importance of matching the energy solution to the duty cycle. Dynamic power may suit captive routes such as mines and quarries, while other freight operations may be better served by depot or opportunity charging.

WP5: Future opportunities, trial requirements & stakeholder engagement

Project Specific Condition 7: Dissemination

Dissemination Actvities

Cycle 5 Alpha Phase Show and Tell Webinar

- Team set to present the projects findings at a UK Power Networks hosted webinar (22/09/2026)

Decarbonisation Working Group (DWG)

- Logistics UK have offered a slot in their DWG event to present the Future Fleet to the Logistic Operators in attendance (23/09/2026)

Energy Decarbonisation Insight Report 2026

- Logistics UK are featuring Future Fleet in their annual report

Sharing Project Outcomes

All project reports are openly shared on both UK Power Networks Microsite and the ENA Smarter Networks Portal:

Future Fleet - UKPN Innovation

Publications:

Project Team Publications:

UK Power Networks Cycle 5 project announcement:
Funding fuels cleaner freight and a fairer energy future

Maritime project announcement:
Maritime Joins Future Fleet Project | Maritime Transport

UK Power Networks Future Fleet press release:
UK Power Networks clearing the path for electric heavy goods vehicles | UK Power Networks

Media Coverage:

Highways Today:
UK Power Networks Mapping the Future of Electric Freight - Highways Today

Motor Transport – Freight Carbon Zero:
UK Power Networks clearing path for electric HGVs | Motor Transport

Definitions: ENA = Energy Network Association

SIF Governance & Next Steps

Risk Register • Finances • Beta Phase

Top project risks

Ref	Risk Description (Summarised)	Likelihood	Impact	Mitigation (Summarised)	Work Package	Risk Owner	Status
R18	**Modelling Dependency on ERM** If Environmental Resource Management (ERM) are unable to deliver on running the SFS models within the required timelines, this may delay the completion of WP4	Medium	Low	Early engagement has been initiated with ERM to align on scope and timelines. The UK Power Networks' DSO team is actively involved in all interactions to support coordination, maintain momentum, and mitigate the risk of delays.	WP4 - Grid Impacts and Business Case	UK Power Networks	Closed
R6	**Stakeholder Unavailability** If key stakeholders are unavailable or unidentifiable for user research, then understanding of user needs and requirements will be delayed.	Low	High	Stakeholder engagement will be conducted in the early phases of Alpha Phase to ensure input from engagement contacts. Project Partners have existing relationships including through their involvement with ZEHID that will be leveraged	WP5 - Future opportunities, trial requirements & stakeholder engagement	UK Power Networks and Voltempo	Closed
R16	**Geospatial Modelling Granularity** If available datasets, both geospatial and non-geospatial do not enable accurate and appropriate mapping to UK Power Networks' network geospatial data, then the project may face delays or quality impacts to geospatial impact assessment. Knock on effects of delayed work from prior work packages resulting in data not being given on time.	Low	Medium	WP4 is led by Baringa, with specialist skills in geospatial data mapping and analysis. This will ensure the skills are available to overcome any unexpected data mapping challenges . Baringa has previously worked with UK Power Networks geospatial data and has a degree of existing familiarity. Engagement has been carried out with key partners including the UK Power Networks' DFES Team, eFreight 2030 partners, Baringa, to ensure that the required data is available and sufficient.	WP4 - Grid Impacts and Business Case	Baringa	Closed
R17	**Trails Protocol Development Dependency** If key outputs from earlier Work Packages, particularly WP3 and WP4, are delayed or incomplete, then the WP5 trials protocol document may be limited, reducing the quality and completeness of the trial design for a subsequent phase.	Low	Medium	The lead partner for WP5 will be actively involved in the preceding Work Packages to ensure the outputs align with the requirements of the protocol document. Early involvement will also ensure clear understanding of dependencies and timelines, reducing the risk of misalignment or late delivery	WP5 - Future opportunities, trial requirements & stakeholder engagement	UK Power Networks and Voltempo	Closed

Project Finances

Project Partner	Total project costs	Project contribution	Total SIF Funding requested
UK Power Networks (Operations) Limited	£43,060	£6,306	£36,754
Baringa Partners LLP	£255,200	£23,520	£231,680
Maritime Transport Limited	£33,000	£3,300	£29,700
Energy Systems Catapult Limited	£124,490	£12,449	£112,041
Voltempo Group Limited	£74,600	£7,460	£67,140
Voltloader Limited	£25,000	£2,500	£22,500
Total	**£555,350**	**£55,535**	**£499,815**

Please note: These are not the final financial figures as final reconciliation has not happened yet

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Beta Phase Plan

Demonstrate that an eHGV fleet delivers tangible benefits for fleet operators and the network. Beyond the environmental gains, it can unlock new income streams through smart charging, battery flexibility, and shared capacity, and these same mechanisms can help tackle the cost and time barriers to grid connection

Engagement

- Engage a diverse range of fleet operators
- Collect data and validate project outputs

National scale archetype analysis and geospatial modelling

- Develop a national and DNO-level model showing the spatial distribution of eHGV charging demand
- Identify and categorise fleet operator archetypes and charging location archetypes across Great Britain

Demonstrate the 'Smart Energy Levers', commercial benefits and feasibility

- Complete trials plan aligned to D5.1.1
- Complete the additional shared capacity and V2G modelling/analysis
- Analyse the trial outcomes

BAU Adoption

- Develop a commercial model report to document the setup and processes required for operators
- Create a connection tool that supports operators through requesting a suitable connection and demonstrates the saving they could gain from adopting the smart levers

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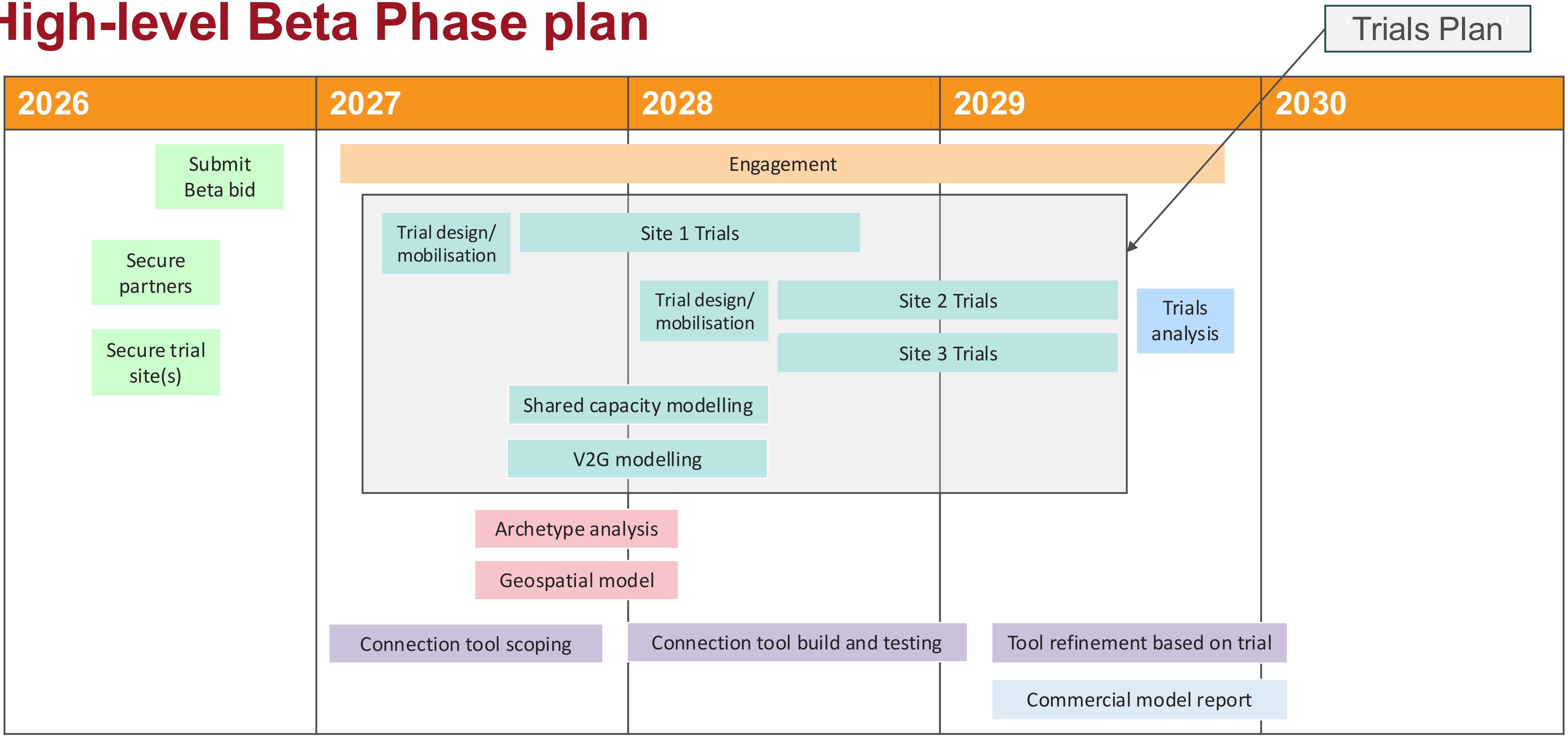
High-level Beta Phase plan



Any Questions?

Appendix

Work Package 2: eHGV fleet charging archetypes

We have developed **fleet and charging location archetypes**, with associated insight into **operator needs**.

This is to inform energy demand modelling, opportunities for smart energy schemes and business models for access to charging.

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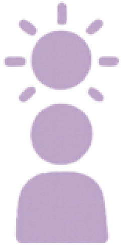
Work Package 2: eHGV fleet charging archetypes

Driver Types

Day Driver



These drivers start early in the morning and finish in the afternoon, starting and stopping at the same location.

Day + Night Driver

HGV is double shifted, so once the day driver has finished another driver takes over for the night shift. The day and night drivers start and stop at the same location.

Long-Haul Tramper

These drivers have the same driving time limitations as the day driver but sleep in their vehicles so can end their journey anywhere.

Work Package 2: eHGV fleet charging archetypes

Journey Types

Shunting

Low mileage, high frequency, regular movements between a depot and a destination.

Round Trip

HGV starts at a depot with cargo, travels to a destination where it drops it off, then picks up cargo at the same location and travels back to the original depot.

One-Way Trip

HGV goes one-way (from a depot to a destination). If returning to a depot it could do this empty, or it can go to another destination to pick up cargo, then travel back to the original depot.

Multi-Drop

HGV has multiple customers' cargo, so the truck stops in multiple destinations along its route.

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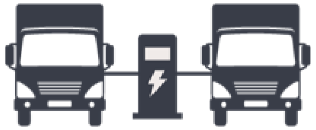
Work Package 2: eHGV fleet charging archetypes

HGV Stop Types

Operators' Depot



Depot owned by a fleet operator where HGVs stop when not in use.

Destination

A drop-off or pick-up location. This could be a fleet's own depot, a customer's depot or a location such as a port.

Dedicated En-Route

Anywhere outside of a depot or destination location (for example motorway services).

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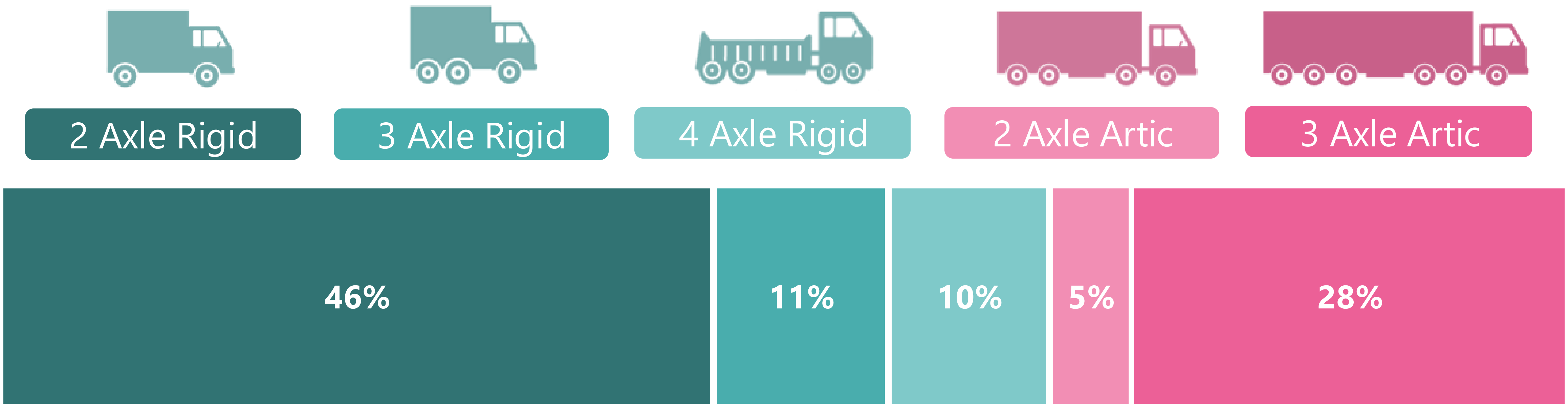
Work Package 2: eHGV fleet charging archetypes

HGV Wheel Configurations



Work Package 2: eHGV fleet charging archetypes

Fleet Types

Restricted – One-Man Bands (1 HGV)

Restricted – SME (11 HGVs)

Standard National – SME (14 HGVs)

Standard International – SME (14 HGVs)

Standard National – Large Fleets (83 HGVs)

Standard International – Large Fleets (99 HGVs)

Definitions: SME = Small Medium Enterprise

Work Package 2: eHGV fleet charging archetypes

Methodology

eFREIGHT 2030

Arrival times at depot and en-route locations

Arrival and dwell times by location and operation

voltloader
CHARGED FOR TOMORROW
MARITIME

By operation:

- No. stops by location
- Dwell times

Vehicles

eFREIGHT 2030

- Consumption
- Distances
- Battery size

Vehicle overview with charging potential by location

voltloader
CHARGED FOR TOMORROW
MARITIME
VOLTEMPO

- Distances per operation
- Operational split
- Charger ratings

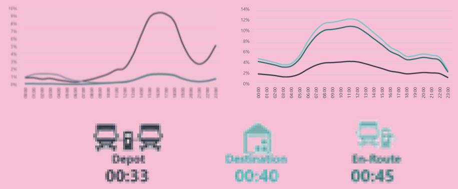
Fleet type overview

Vehicle Split

Operation Split

Charging Potential

Arrival & Dwell Times



Journey Details

Work Package 2: eHGV fleet charging archetypes

Standard National – Large Fleets

Vehicle Types

3 Axle Artics
42

2 Axle Rigids
20

4 Axle Rigids
9

2 Axle Artics
7

3 Axle Rigids
5

Driver Types

75%
Day Drivers

10%
Day + Night Drivers

15%
Long-Haul Trampers

Journey Types

38%
Round Trips

33%
One-Way

19%
Multi-Drops

9%
Shunting

Daily Electricity Demand

Average Daily Energy Consumption:
37,000 kWh

73% delivered at **Depot**

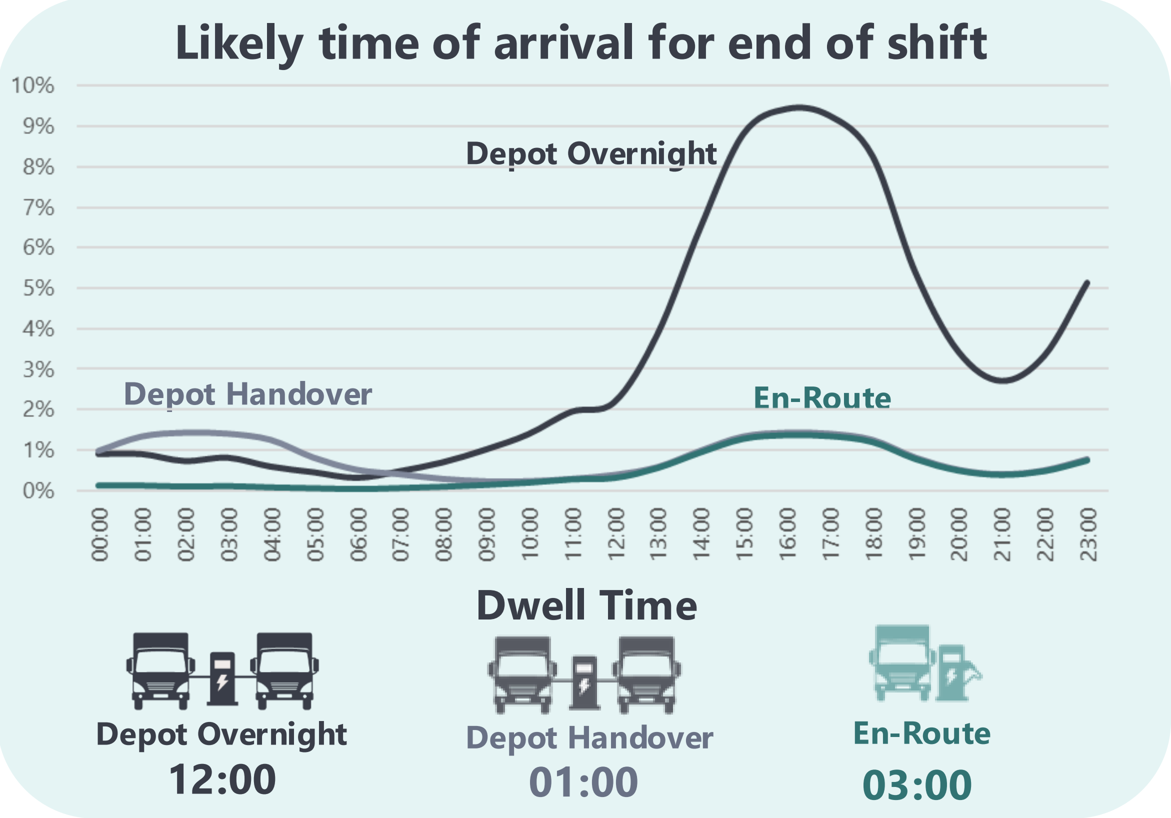
18% delivered at **Destination**
(potential for **62%**)

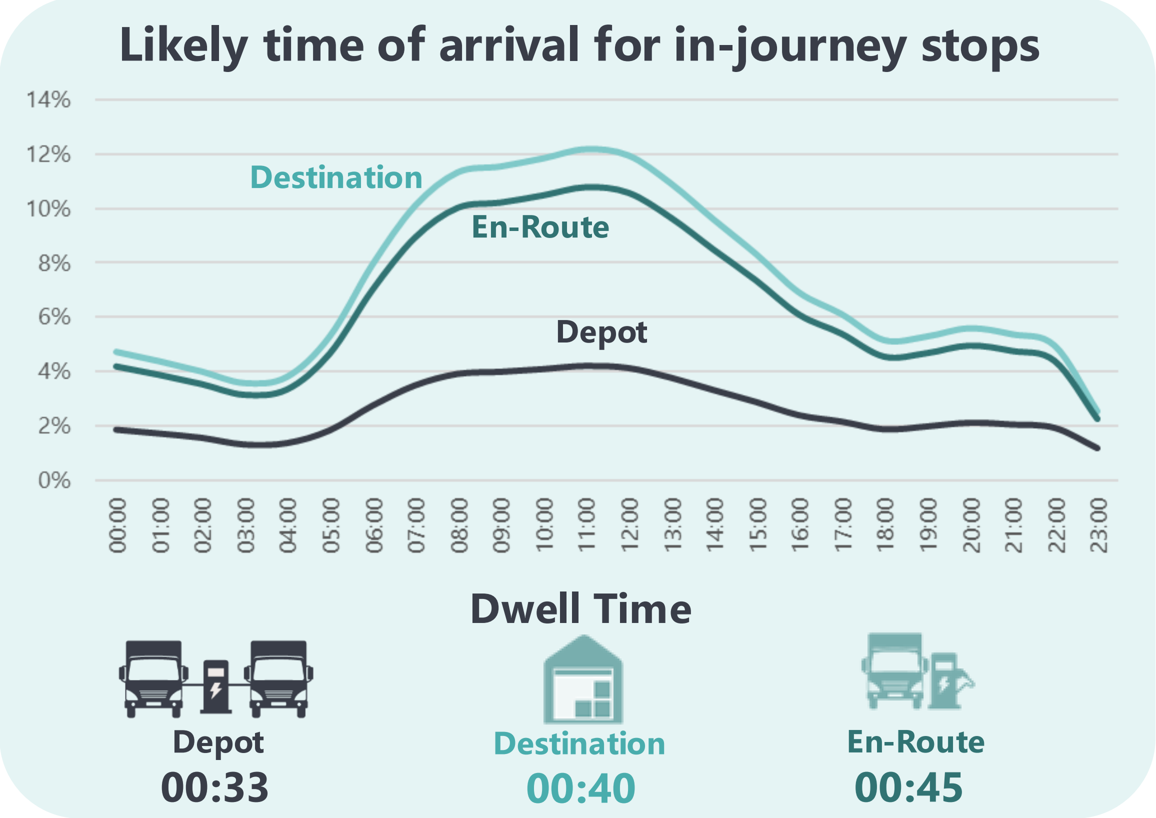
9% delivered at **Dedicated En-Route**
(potential for **84%**)

Work Package 2: eHGV fleet charging archetypes

Standard National – Large Fleets – Average Vehicle

Daily energy consumption	Daily distance	In-Journey stops
450 kWh	255 km	4





Work Package 3: Smart energy management schemes and business models

Smart energy levers can help integrate concentrated and growing eHGV fleet demand in areas with constrained grid capacity

Grid challenges

1. Peak capacity constraints causing slow and high-cost grid connections
Local networks cannot accommodate high, coincident charging demand

2. System balancing & renewable integration causing rising system costs
Greater need to match demand with variable renewable generation

3. . Maintaining high network utilisation while avoiding higher societal costs
Capacity is sized for peak demand, even where that peak capacity may only be used for limited periods, increasing societal costs

4. Concentrated demand causing localised network bottlenecks
Charging demand will cluster around depots and logistics hubs, creating peaks that may exceed available network capacity

Smart energy levers

1. Smart Charging
Optimise charging away from peak network periods and towards periods with lower electricity costs

2. On-site Energy
Use on-site assets to reduce grid import (e.g. battery solutions, solar PV, vehicle-to-grid etc.)

3. Dispersed Charging
Locate charging where it best aligns with capacity, site operations, and cost, whether through dispersed sites or strategic clustering

4. Shared Sites with Spare Capacity / Smart Energy Zones
Co-locate charging at sites that have spare capacity and/or synergistic loads

The challenge is not just connecting load — it is integrating large, geographically concentrated demand into a constrained system with increasing intermittent renewable energy

Definitions: Solar PV = Solar Photovoltaic

Work Package 3: Smart energy management schemes and business models

Our fleet and geospatial modelling suggests most charging demand will occur at depots overnight, with larger depots likely to be the most challenging to connect

	Small depot	Medium depot	Large depot	Destination charging	En-route charging
Description	Average of 5 trucks charging per day, largely overnight	Average of 35 trucks charging per day, largely overnight	Average of 150-200 trucks charging per day, largely overnight	*Not estimated*	*Not estimated*
# of sites in UKPN area	2,300	830	97	*Not estimated*	*Not estimated*
Average import capacity (kVA)	**250-300**	**2,000**	**8,000 to 10,000**	**Highly site-specific**	**Highly site-specific**
Share of total charging demand	**20-25%**	**45-50%**	**22-28%**	**5-10%**	**3-7%**
Potential connection challenges	• Least challenging to connect but delays still possible in constrained areas • Spare headroom may enable flexible charging in response to wholesale / network signals	• Increasingly constrained at upper end, may drive feeder reinforcements • Battery storage may help avoid reinforcement thresholds • Overnight charging may drive peak demand	• Most likely to trigger major reinforcement works • Long lead times and high capex risk • May require phased energisation or flexible connection arrangements • Strongest case for coordinated / shared infrastructure approaches	• Wide variation in site suitability and dwell time • Commercial ownership and operational complexity • Urban sites may face space and connection constraints • Charger mix (fast vs slow) strongly affects peak demand	• Low dwell times reduce charging flexibility • High-power chargers drive large peak demand • Motorway/strategic road locations may already be constrained • Significant reinforcement risk for concentrated charging hubs

WP2 & WP4 outputs

High
Medium
Low

Modelling implications

- Medium and large depots are expected to be the most challenging to connect due to greater import capacity requirements and potential clustering, we intend to map the geographical distribution of depot archetypes to primary substations to test this hypothesis (WP4 synthesis)
- We are modelling these scenarios at a site level to test impact on grid requirements and smart energy lever economics, as well as extrapolating them to UK Power Networks and GB level for the CBA

Definitions CBA = Cost Benefit Analysis

Work Package 3: Smart energy management schemes and business models

A techno-economic model was developed to quantify the long-term impact of smart energy interventions on depot electrification costs and connection requirements

Objective

To assess how different smart energy levers influence the economics and deliverability of eHGV depot electrification across a range of fleet and network archetypes, and to identify the most promising interventions to support scalable, cost-efficient network connections; acting as a key input into detailed business model assessment and future trial deployment.

Modelling Approach

The analysis evaluates the long-term costs and benefits of Smart Energy Levers 1–2 across representative depot archetypes based on WP2 outputs, comparing conventional charging approaches against more sophisticated energy management solutions.

The model combines:

- Fleet charging demand profiles derived from WP2 operational archetypes
- Depot size archetypes (small, medium and large)
- Network connection requirements and UKPN connection cost assumptions
- Smart charging optimisation strategies (Lever 1)
- On-site solar and battery deployment scenarios (Lever 2)
- Wholesale electricity, flexibility and ancillary service revenues
- Asset capital expenditure, replacement, and O&M costs

Scenarios Evaluated

The modelling compares a range of representative site archetypes:

- **Baseline charging** (unmanaged charging)
- **Lever 1: Smart charging optimisation**
- **Lever 2: Smart charging + battery storage**
- **Lever 2: Smart charging + battery storage + solar PV**

For each archetype, scenarios are assessed under different connection capacities and network cost assumptions to assess how levers interact with grid constraints.

Outputs

The modelling provides:

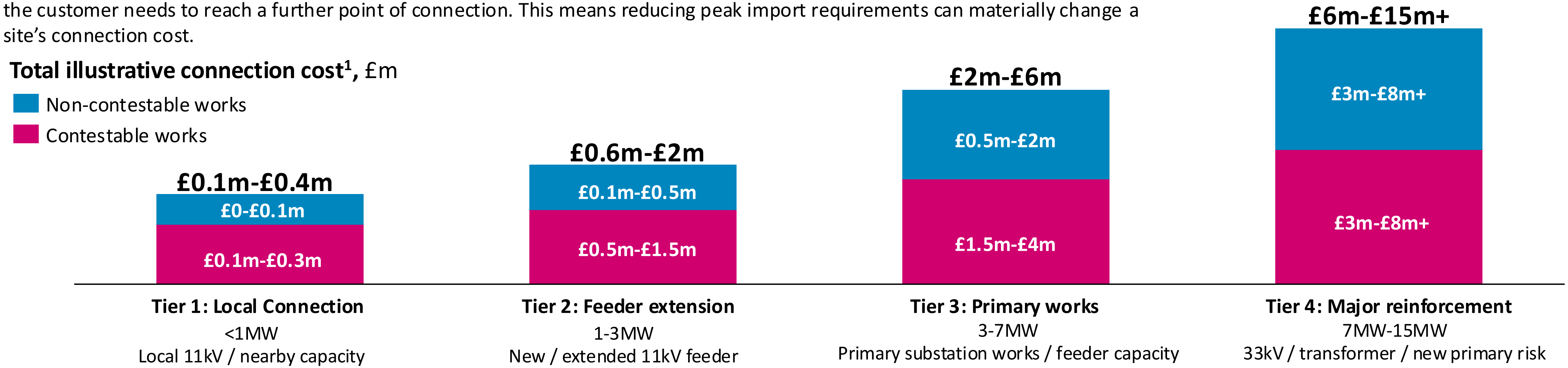
- 20-year undiscounted energy and infrastructure site costs
- Discounted net site cashflow (£NPV)
- Levelised charging costs (£/kWh)
- Connection cost sensitivities
- Flexibility and energy value breakdowns
- Comparative economics across depot archetypes
- A benchmark of eHGV charging cost against diesel operating costs
- Insights to support trial site identification, business model design, and inputs for WP4 cost-benefit assessment

O&M = Operations and Maintenance

Work Package 3: Smart energy management schemes and business models

Connection costs are a key modelling input because smart energy levers are only economical at the site-level relative to a connection cost

Connection costs do not scale linearly on a £/MW basis. They are driven by threshold jumps, sole-use extension assets and whether the customer needs to reach a further point of connection. This means reducing peak import requirements can materially change a site's connection cost.



Modelling implications

- Connection capex is treated as a threshold-driven (Low/Medium/High) scenario input, not a linear £/MW assumption
- BESS and solar are tested against the cost of securing a larger firm maximum import capacity (MIC)
- The value case is driven by whether smart energy levers can meet site charging demand whilst reducing connection capex

Case study example: Nissan Sunderland Plant & GRIDSERVE

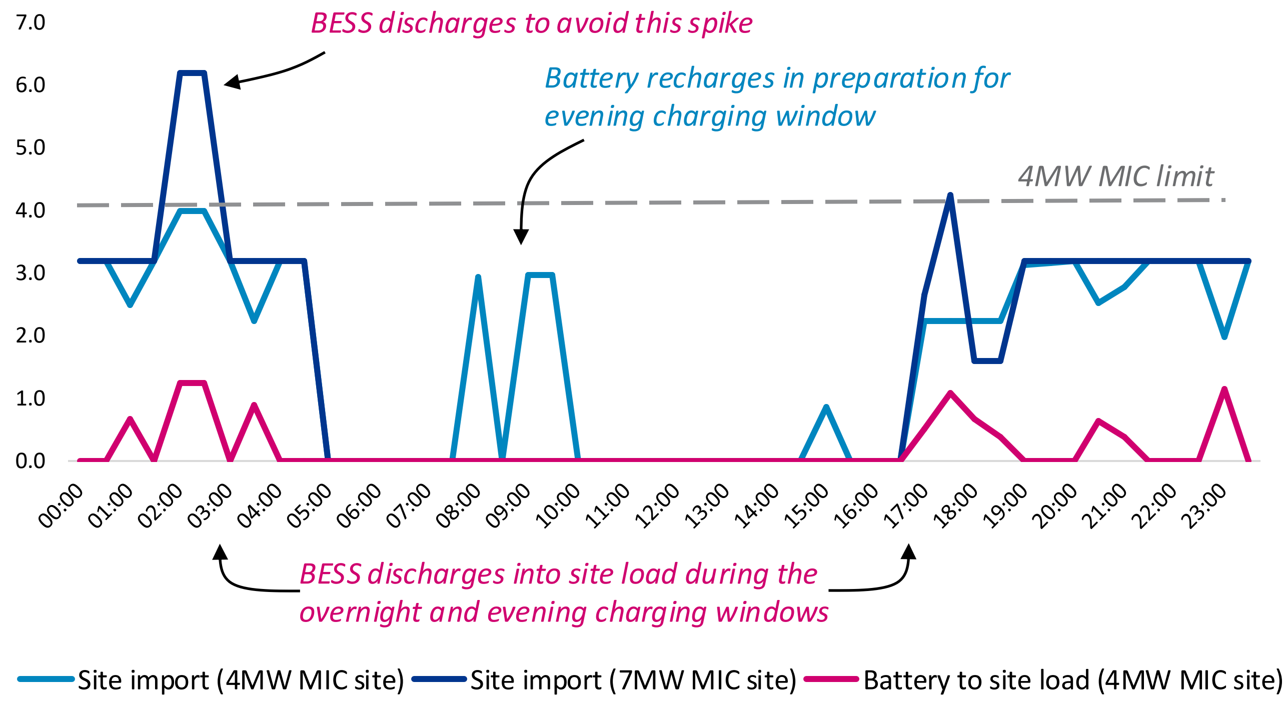
- On-site civils and enabling works can be a material cost driver for eHGV charging sites, particularly where sites require significant groundworks
- The Nissan Sunderland & GRIDSERVE project delivered a £1.4m shared eHGV charging depot, with 10 high-power charging bays to support an initial 25 electric HGV fleet
- The project was enabled through the Innovate UK and DfT-funded ZEHID[2] programme, showing that high upfront infrastructure and civils costs may require public funding support to make early deployments viable

Notes: (1) Illustrative connection costs that were developed in discussion with the UK Power Networks Connections Team. (2) Zero Emission HGV and Infrastructure Demonstrator (ZEHID)

Definitions: BESS = Battery Energy Storage System

On-site BESS can reduce depot MIC requirements by meeting the gap between charging demand and lower grid import capacity

Depot import profile showing how BESS supports charging demand under a lower MIC
Example from the medium depot handover sensitivity, comparing a 7MW smart charging case with a 4MW smart charging + BESS case



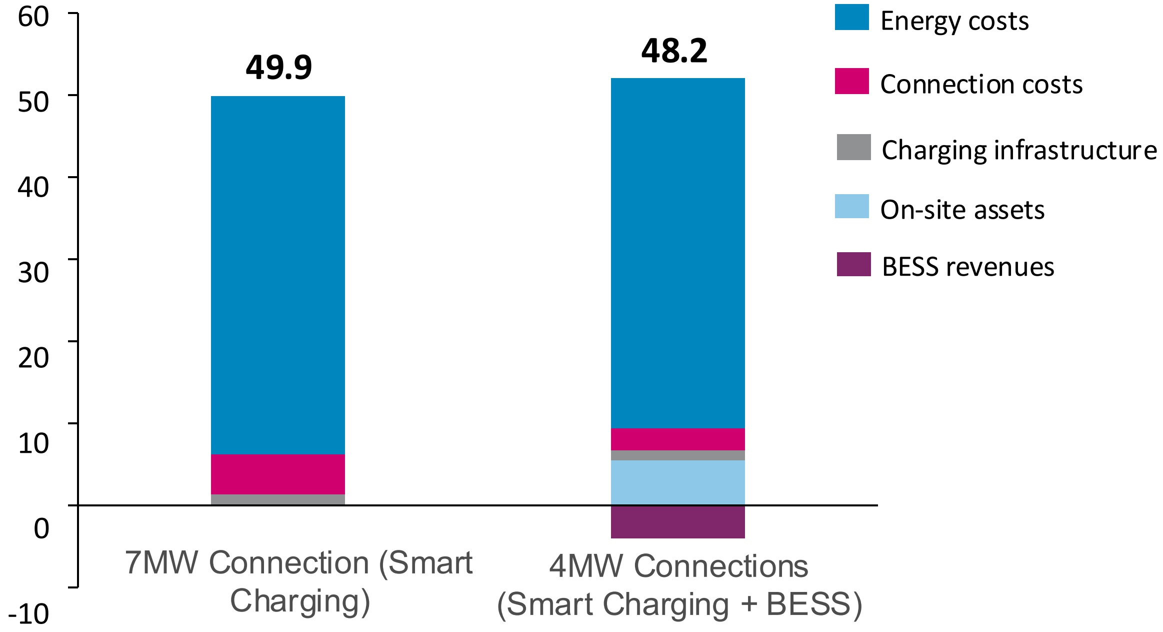
- **This profile shows how BESS can act as a bridging asset between site charging demand and a lower MIC, allowing the same fleet demand to be served.**
- **This sensitivity assumes overlapping overnight and handover[1] charging, creating a coincident peak that would require a 7MW firm connection.**
- In the 4 MW case, the BESS charges when there is headroom and discharges into site load during the charging windows.
- This reduces the grid import needed to serve the same charging demand, enabling a lower MIC.
- The sensitivity assumes overnight chargers are available 17:00–05:00, while handover chargers create short additional charging spikes at 02:00 and 17:00. The peak periods are driven by this overlap.

Definitions: MIC = Maximum Import Capacity

Work Package 3: Smart energy management schemes and business models

For medium depots with coincident evening peaks driven by handover duty cycles, BESS can reduce required MIC by ~40% while serving fleet demand at a lower overall cost

20-year undiscounted cost stack for medium handover depot charging scenario[1], £m (real 2026)



	7MW Connection (Smart Charging)	4MW Connections (Smart Charging + BESS)
Discounted net site cost NPV (£m)	31.8	31.3
LCOE (p/kWh)	10.7	10.6

Notes: (1) Based on WP2 outputs, assumes 65 × 50 kW overnight chargers with a 17:00–05:00 charging window and 15 × 200 kW handover chargers with 02:00–03:00 and 17:00–18:00 charging windows. Energy costs use Baringa's Wholesale and Retail Price projections. Bars show 20-year real costs in 2026 prices; NPV is discounted at 6%. Detailed modelling assumptions are included in the appendix. A "handover" duty cycle reflects vehicles returning briefly between shifts, creating a short charging window that can overlap with overnight charging.

Modelling sensitivity

This sensitivity tests a medium depot where overnight and handover duty cycle charging overlap during the evening peak. This short coincident peak drives the need for a 7MW firm connection.

1. **BESS becomes the lowest-cost option where evening peaks exist**
   - Reduces site cost NPV from £31.8m to £31.3m
   - Marginally lowers LCOE from 10.7p/kWh to 10.6p/kWh
2. **BESS enables a 40% smaller connection**
   - Reduces max import capacity from 7MW to 4MW
   - Can lower connection capex by 50%, from £5m to £2.5m
3. **Value is driven by avoiding larger connection costs, not energy savings alone**
   - BESS bridges the short evening peak created by overlapping duty cycles
   - Additional value comes from avoided connection capex and flex revenues

Key Takeaway

For medium depots with coincident peaks driven by overlapping charging patterns, BESS becomes valuable because it can avoid a larger grid connection threshold and enables a lower LCOE

Scenario	Connection capex (£m)	BESS capex (£m)	Total upfront CAPEX (£m)
7MW Smart charging	5	-	5
4MW Smart charging + BESS	2.5	3.6	6.1