Future Fleet

WP4: Energy system cost/benefit assessment report

August 2026

Linking the WP4 geospatial outputs with the network impact analysis and CBA

How WP4 geospatial demand, WP3 charging profiles and UKPN network data are combined to assess primary-level reinforcement impacts and feed the CBA and Carbon Benefit Model

INPUTS

SFS network inputs
- Primary substation / grid-site reference
- Winter & summer peak demand (MW)
- Firm capacity (MVA)
- Reinforcement cost assumptions (£ per intervention / scheme)

Future Fleet demand assumptions
- Archetype load profiles for each charging scenario.
- Asset-specific profiles are applied only to the assumed uptake share; remaining depots use the smart charging profile.

Geospatial outputs
- Annual eHGV uptake trajectory aligned to DFES
- Depot to primary / grid-site mapping to match SFS network inputs

CALCULATIONS

1 Import SFS network inputs
- Load primary-level demand & firm capacity by year
- Load reinforcement cost assumptions

2 Overlay Future Fleet eHGV demand profiles
- Scale depot geospatial demand to the DFES eHGV trajectory
- Apply the relevant WP3 charging profile by archetype and scenario

3 Build primary-level demand profiles
- Map depot demand to corresponding primary substations
- Aggregate eHGV demand by primary by year

4 Assess network capacity
- Combine background network demand with eHGV charging demand
- Compare winter and summer demand against firm capacity

5 Identify reinforcement requirements
- Identify when demand first exceeds firm capacity across each scenario
- Record reinforcement requirement and timing

6 Calculate network cost impact and compare scenarios
- Apply reinforcement cost assumptions to build annual cost profile
- Compare scenarios; quantify timing, deferral & cost impacts

OUTPUTS

Primary-level outputs
- Trigger year by season (winter / summer)
- Capacity breach (Y/N) & reinforcement requirement
- Reinforcement cost (£) by year

Scenario outputs
- Network impact by Future Fleet scenario
- Reinforcement timing / deferral
- Impact on peak demand
- Annual and cumulative reinforcement cost impact to 2049

SIF-CBA outputs
- Annual avoided network reinforcement cost
- Primary-level breach and available-headroom outputs
- Comparative load profiles to assess carbon impact

Methodology: SFS network data, Future Fleet demand assumptions and geospatial mapping outputs are combined to build annual primary-level demand profiles. These are compared against firm capacity to identify reinforcement triggers and quantify network infrastructure and cost impacts for each Future Fleet scenario. Carbon benefits are added separately when results are brought into the Ofgem SIF CBA template.

Option 3 (smart charging, BESS & solar) delivers £4.75bn whole-life NPV across UKPN's licence area, with additional unquantified value from enabling earlier grid connections

Key assumptions

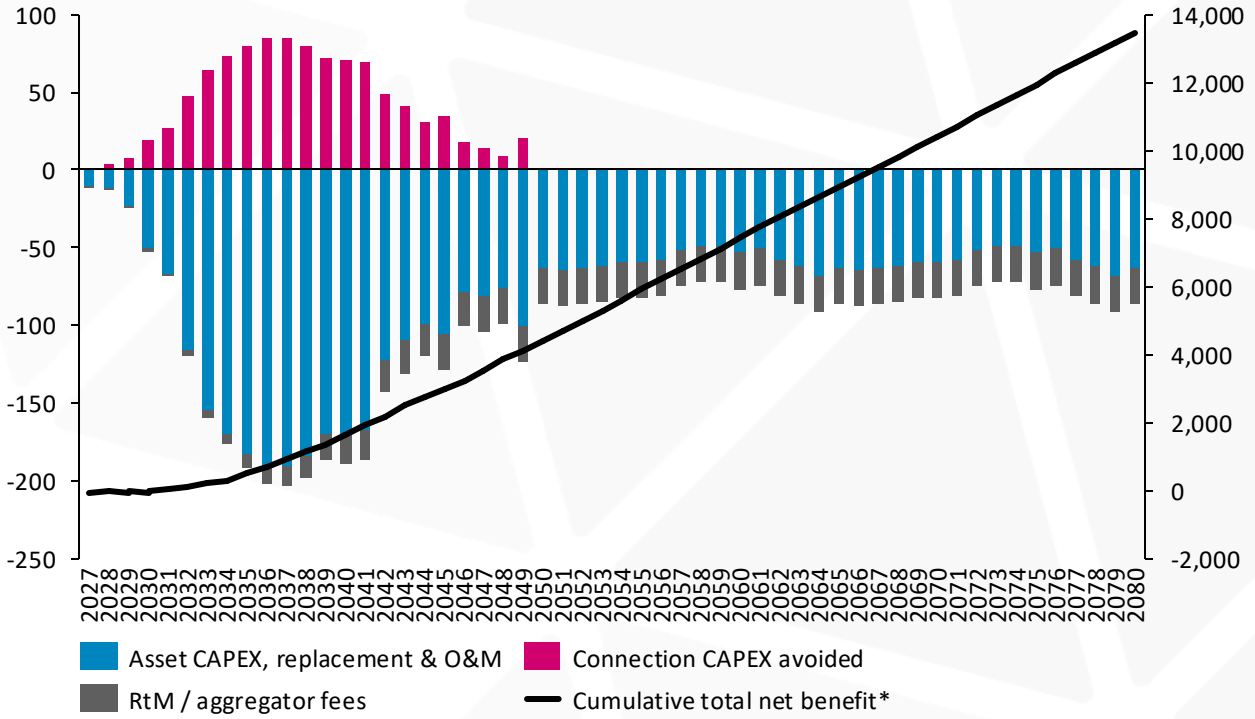
- **Depot growth and location:** WP4 geospatial modelling identifies expected eHGV depot locations and maps them to UKPN primary substations. Demand is scaled against UKPN's DFES Holistic Transition trajectory, with locations reclassified between Small, Medium and Large archetypes as they grow.
- **Charging and asset assumptions:** WP3 provides the half-hourly archetype load profiles, asset sizing and site-level energy economics. Under Option 3, BESS and solar uptake is 20% Small, 50% Medium and Medium-handover, and 70% Large; remaining depots use Smart Charging only. A separate Carbon Benefit Model quantifies the associated emissions impacts.
- **Network and connection benefits:** Each mapped depot is assigned its relevant WP3 load profile and aggregated to its UKPN primary. The Network Impact Analysis Model combines this with background demand to identify capacity breaches and reinforcement costs. Connection savings use an estimated 55% contestable / 45% non-contestable split informed by the UKPN Connections Team, with the contestable share captured as the depot-side benefit.
- **CBA inputs and time horizon**: Detailed depot, network and carbon model inputs end in 2049 (when substation capacity projections end). From 2050, the 2049 installed asset stock and recurring annual operating costs and benefits are held flat. No new asset capex or connection savings accrue, while replacement costs continue in line with asset lifetimes through 2080.

	Discounted NPV
Financial net benefits – avoided network reinforcement	£3,709m
Environmental net benefits	£189m
Societal net benefits	£852m
Total net benefit	**£4,750m**

SIF CBA discount rate: 3.5% for the first 30 years and 3.0% thereafter.

Option 3 annual costs and connection benefits
£m (2023/24 prices), undiscounted

Cumulative total net net benefit*
£m (2023/24 prices), undiscounted



*Cumulative total net benefit includes avoided network reinforcement alongside societal and environmental net benefits. Bars show selected annual asset, operating and connection-related drivers and therefore do not sum directly to the cumulative line

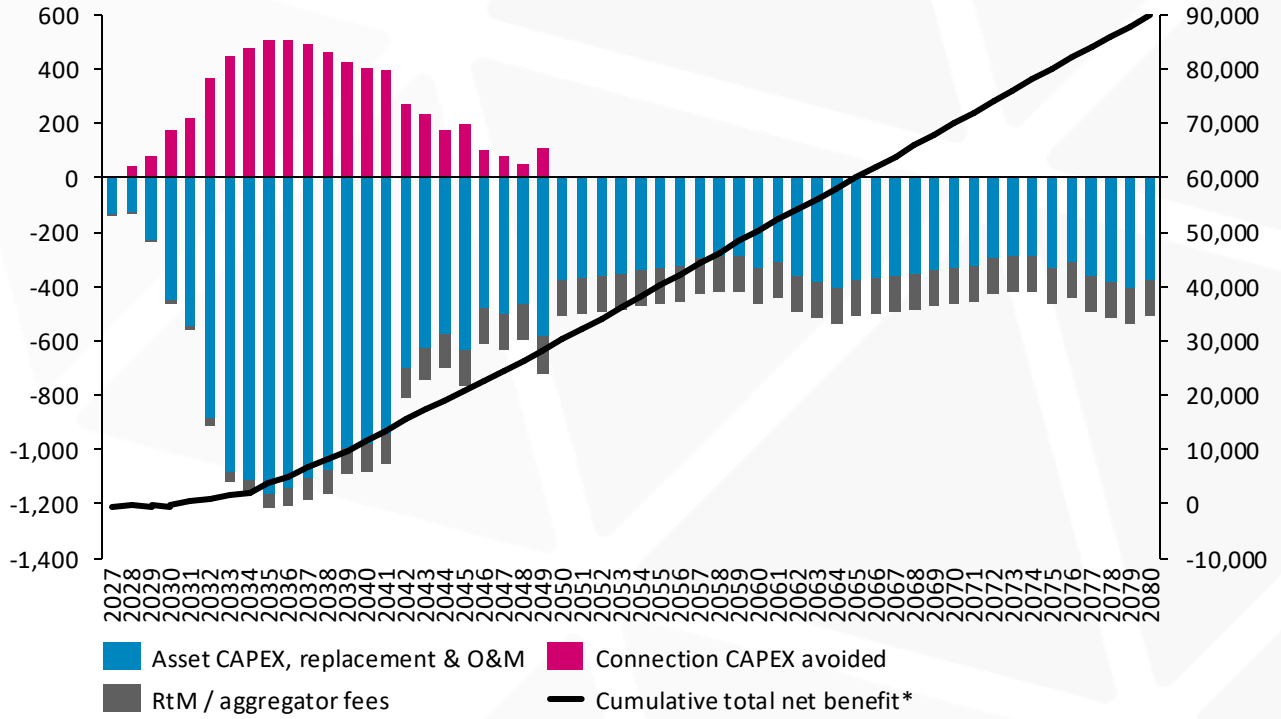
This scales to a whole-life NPV of £32.1bn at GB level for Option 3 (smart charging, BESS & solar)

Key assumptions

- **GB scaling approach:** UKPN outputs are converted to GB using the GB/UKPN eHGV ratio for each year to 2049, based on the FES and DFES Holistic Transition trajectories. The 2049 ratio is held constant thereafter
- **Asset uptake assumption**: The same depot archetypes, WP3 charging profiles, asset sizes and uptake assumptions are used at GB level. Uptake is 20% for Small, 50% for Medium and Medium-handover, and 70% for Large depots. Remaining depots use Smart Charging only.
- **CBA treatment:** The same cost, revenue, carbon and post-2049 assumptions used for UKPN are retained at GB level, including the modelled asset replacement cycles.
- **Important caveat:** GB results are an extrapolation of the UKPN analysis using GB eHGV volumes; they are not a separate GB-wide primary substation level assessment.

Option 3 annual costs and connection benefits
£m (2023/24 prices), undiscounted

Cumulative total net net benefit*
£m (2023/24 prices), undiscounted



*Cumulative total net benefit includes avoided network reinforcement alongside societal and environmental net benefits. Bars show selected annual asset, operating and connection-related drivers and therefore do not sum directly to the cumulative line

	Discounted NPV
Financial net benefits – avoided network reinforcement	£26,594m
Environmental net benefits	£1,158m
Societal net benefits	£4,332m
Total net benefit	**£32,084m**

SIF CBA discount rate: 3.5% for the first 30 years and 3.0% thereafter.

Option 3 avoids c.1.0 $MtCO_2e$ across UKPN's licence area and c.6.0 $MtCO_2e$ GB-wide over the CBA horizon, with most savings driven by avoided diesel emissions

Key assumptions

- **Direct emissions benefits:** The Network Impact Analysis identifies the additional eHGVs that can connect under Option 3 relative to unmanaged charging, based on the additional network headroom created. The Carbon Benefit Model calculates the diesel emissions avoided by these additional vehicles using archetype-specific annual mileage assumptions and DESNZ emissions factors.
- **Indirect emissions impacts:** Across the connected eHGV fleet, the model compares electricity-related emissions under Option 3 with unmanaged charging using the WP3 half-hourly charging profiles and Baringa's projected grid carbon intensity. This captures changes in charging timing, BESS losses, and on-site solar generation.
- **Indirect vs Direct benefits:** Option 3 does not materially change the energy required to operate vehicles that are already electric. It mainly changes when and how electricity is supplied. As the grid decarbonises, the emissions difference between charging strategies becomes relatively small. Enabling an additional eHGV to connect, by contrast, displaces diesel operation and creates a much larger carbon saving.
- **Model horizon and scaling**: Detailed carbon modelling runs to 2049. The 2049 annual carbon benefit is held flat through 2080 in the CBA. GB results use the same GB/UKPN eHGV scaling methodology as the wider CBA.

Cumulative carbon emissions savings from Option 3, 2027–2080

$MtCO_2e$