NIC Project UKPNEN03

Project Close Down Report

April 2023

Optimise Prime

HITACHI Inspire the Next · Uber · Scottish & Southern Electricity Networks · centrica · Royal Mail · UK Power Networks

Table of acronyms & glossary

The acronyms and terms used throughout this document are clarified below.

Table 1 – Table of acronyms

Acronym	Full form
ANM	Active Network Management
API	Application Programming Interface
CP	Charge Point
CPC	Charge Point Controller
DFES	Distribution Future Energy Scenarios
DNO	Distribution Network Operator
EV	Electric Vehicle
FSP	Flexibility Service Provider
FU	Flexible Unit
GB	Great Britain
ICEV	Internal Combustion Engine Vehicle
IPR	Intellectual Property Rights
IT	Information Technology
kVA	Kilovolt-Ampere
kW	Kilowatt
LCV	Light Commercial Vehicle
LSOA	Lower Layer Super Output Area
LV	Low Voltage
MVA	Megavolt-ampere
MW	Megawatt
MWh	Megawatt hour
NIC	Network Innovation Competition
PHV	Private Hire Vehicle
RFID	Radio Frequency Identification
SFS	Strategic Forecasting System
SoC	State of Charge
SSEN	Scottish & Southern Electricity Networks
TCO	Total Cost of Ownership
TOA	Trial Operational Applications
UK	United Kingdom
USP	Universal Service Platform
WS	Workstream

Table 2 – Glossary of terms

Term	Definition
Unmanaged charging	Charging of an EV at the rate set by the connection until it reaches full charge or is disconnected.
Smart charging	Charging via a smart charger equipped with two-way communication, enabling charging habits to be adaptive.
Flexibility	The ability to respond dynamically to a signal provided by the distribution network operator (DNO) to increase or decrease the power exchanged with the network, compared to an initial planned behaviour. In Optimise Prime there are 3 flexibility products: Product A – Firm Forward Option; Product B – Day Ahead; Product C – Intraday.
Profiled connection	A connection agreement where the applicable maximum demand limit (in kVA) varies according to the time of day and the season, up to 48 half-hourly time slots per day, with adherence to the profile actively managed through behind-the-meter smart systems and monitored by the DNO.
Project Direction	The formal notification from Ofgem setting out the terms of funding for the project

1 Project background

The Optimise Prime project was awarded funding by Ofgem in the 2018 Network Innovation Competition (NIC) and ran from January 2019 to February 2023. The project carried out a number of trials in order to understand and minimise the impact the electrification of commercial vehicles will have on distribution networks. The Optimise Prime developed technical and commercial solutions to save customer costs and enable the faster transition to electric for commercial fleets and Private Hire Vehicle (PHV) operators.

Optimise Prime was a third-party industry-led electric vehicle (EV) innovation and demonstration project that brought together partners from leading technology, energy, transport and financing organisations, including Hitachi Vantara, UK Power Networks, Centrica, Royal Mail, Uber, Scottish & Southern Electricity Networks, Hitachi Europe and Novuna Vehicle Solutions. Details of the partners and their roles in the project can be found in Appendix 1.

The project gathered data from over 8,000 EVs driven for commercial purposes through three trials in order to help GB's distribution networks plan and prepare for the mass adoption of EVs.

The project consisted of three trial workstreams (WS):

- WS1, investigating the impact of commercial vehicles charging at homes
- WS2, monitoring and optimising commercial vehicles charging in depots
- WS3, which used PHV journey data to model the impact of these vehicles on the distribution network.

Two Methods were tested as part of the project:

- Flexibility services to DNOs from commercial EVs on domestic connections
- Planning tools for depot energy modelling, optimisation with profiled network connections.

Optimise Prime's outcomes include:

- Insight into the impact of the increasing number of commercial EVs being charged at domestic properties, and commercial solutions for managing home based charging
- A site planning tool and analysis of optimisation methodologies enabling an easier and more cost-effective transition to EVs for depot-based fleets
- A methodology for implementing profiled connections for EVs, implemented in coordination with network planning and active network management tools
- Learnings regarding how useful and commercially attractive flexibility services from commercial EVs can be to DNOs, and how such services could be implemented
- A significant dataset and accompanying analysis on the charging behaviour of commercial vehicles

2 Executive summary

2.1 Project background

Optimise Prime aimed to create a detailed understanding of the impact of commercial EVs and the opportunities for flexibility. The insights created by the project allow licensees to accurately forecast demand and plan mitigations, including flexibility and profiled connections, which allow to minimise costs for the connected and connecting customers. Depot based tools and home charging strategies were trialled to allow fleet and PHV operators to electrify more quickly and cost effectively, without negatively impacting the distribution network.

The project brought together a diverse group of organisations across energy, fleet operations, technology and finance in order to gather the required data, deliver solutions and thoroughly test them in operational environments.

The four-year project received funding from the Network Innovation Competition of £16.4m. The project partners also made significant in-kind contributions to the project. The project underspent by £1,725,966, and this balance will be returned to customers who had ultimately funded this project.

2.2 Scope of the project

Optimise Prime's objectives are summarised by three key questions that were set out in the project's full submission:

- How do we quantify and minimise the network impact of commercial EVs?
- What is the value proposition for smart solutions for EV fleets and PHV operators?
- What infrastructure (network, charging and IT) is needed to enable the EV transition?

In order to answer these questions, the project ran trials with three partner fleets:

- British Gas vehicles that principally charge at homes
- Royal Mail vehicles that charge in depots
- Uber PHVs that use a mixture of public and home charging infrastructure.

The project collected data on the operation of the vehicles from a number of sources, including:

- Telematics systems
- Charging management platforms
- Load monitoring
- Uber's operational systems.

Two project Methods were tested as part of the project:

- Flexibility services to DNOs from commercial EVs on domestic connections (Method 1)
- Planning tools for depot energy modelling, optimisation with profiled network connections (Method 2).

These methods were designed to help fleets electrify more quickly by removing potential barriers related to connection cost and capacity through more efficient use of existing network capacity. The Methods were also predicted to reduce costs for network customers through the deferral or avoidance of network upgrade works.

2.3 Outcomes of the project

The project successfully carried out trials covering three use cases:

- Commercial vehicles charged at drivers' homes

- Commercial vehicles charged at depots
- PHVs, which can use public or private charging infrastructure.

In doing so, the project collected a large amount of data on the operations and charging of commercial EVs, covering over two million driver shifts. Where possible this data has been made publicly available, and detailed findings from the analysis of this data has been published in the project's deliverables and on UK Power Networks' Open Data Portal, together with learnings regarding impacts on distribution networks and fleet operators.

Complementing the trials, Optimise Prime carried out significant research and economic modelling activities. Over 2,000 survey responses were collected from drivers and managers across multiple fleets, identifying attitudes towards EVs and specific concerns regarding the EV transition that need to be addressed. Total Cost of Ownership (TCO) analysis, based on the partner fleets, helped identify the main drivers of costs for EVs vs. internal combustion engine vehicles (ICEVs) across several scenarios and highlighted the potential impacts of participation in the project methods.

The trials of the project methods have resulted in several useful outputs for project stakeholders, including:

- Recommendations on the commercial implementation of flexibility services and profiled connections by DNOs
- A site planning tool that can be used to plan profiled connections and to encourage fleet customers to consider how they can manage the electrical loads of their sites
- An electrification guide for fleets based on lessons learned from the trials and knowledge accumulated by the project partners
- A substantial EV usage and charging dataset.

An updated project business case has been created based on the trial results and utilising UK Power Networks' load flow-based network modelling and costing methodology. This has shown that the project's methods can result in significant savings for network customers and environmental benefits. In total this is expected to result in a saving to network customers of £196m, a capacity saving of 2,876MVA and a reduction in CO_2 emissions of 3.8 million tCO_2e by 2040.

These figures are, however, lower than what was forecast in the original business case, due to a number of factors, including the more accurate calculation methodology used in this update, and the reduced impact of commercial EVs on peak load identified in the trials. These factors, together with some of the additional benefits from the project not captured in the initial business case, can be found in Section 8.1 of this report.

2.4 Objectives and deliverables

The project's core objective was to answer the three key questions, which are presented in Table 3 together with how the project answered them.

Table 3 – Key project questions

Question	What the project did
How do we quantify and minimise the network impact of commercial EVs?	Optimise Prime trialled two methods to reduce the impact of commercial EVs on the distribution network. The impact of commercial fleets charging on the network was modelled using detailed data from the vehicle charging. The results of these trials were quantified and, where necessary, recommendations were made for the further development and rollout of the methods.

Question	What the project did
What is the value proposition for smart solutions for EV fleets and PHV operators?	The project analysed the TCO of EVs, with several scenarios produced based on the project partners' fleets. As part of this work, the potential savings or revenues that customers could achieve through implementation of smart charging, profiled connections or flexibility provision were assessed and quantified.
What infrastructure (network, charging and IT) is needed to enable the EV transition?	Technical solutions were implemented and tested by the fleets and network operators. Based on these trials, a set of recommendations were produced for implementation of the project methods and an electrification guide for fleet operators was produced.

The full answers to these questions, together with a wide range of supporting information and analysis can be found in the seven deliverables that were published throughout the course of the project – consisting of six reports and a series of data sets.

All deliverables were completed successfully and submitted in line with the schedule agreed with Ofgem. Links to the deliverables can be found in Section 13.1 of this report.

2.5 Learning generated by the project

The learning from the project covered an array of areas dealing with organisational, financial, planning and technical issues in addition to the insights gained from the analysis of the project data and the trial of the project methods. Full details of these findings can be found throughout the project deliverables, with some key learnings including:

- Unmanaged, home-based fleets will create concentrated load peaks from 17:00 due to the timing of the end of shifts coinciding with network peaks
- Depot load profiles are site specific and can change seasonally, with two main peaks appearing at 14:00 and 19:00, which follow the depot delivery schedules. More rural Royal Mail depots are likely to see their demand peak in the afternoon
- Most (77%) demand from PHVs occurred 'off-shift', with plug-ins peaking at about 20:00, but continuing through the night – later than other fleets would normally plug in
- It is expected that the rapid growth in the number of Uber EVs will result in a maximum load from off-shift charging in Greater London increasing from an estimated 10 MW in May 2022 to 69 MW by the end of 2025. Over the same period, annual electricity demand from these EVs is expected to reach 497 GWh, compared to 63 GWh used in the year to May 2022. Based on modelling of driver shift times, charging needs and home locations, Optimise Prime estimates that approximately 33,500 fast charge points may be required to service this demand if drivers opt for overnight fast charging.
- Winter EV energy requirements can be up to 30% higher than in the summer
- Smart charging can be very effective at changing load patterns, however it may lead to significant secondary peaks overnight. Incentives to drive the smart charging behaviour (such as through flexibility services or varying profiled connections) should be considered to reduce the impact of this behavioural change on the network.

2.6 Learning derived from the Methods

The project tested two methods as part of the trials – a trial of flexibility services focused around the home based British Gas fleet (Method 1) and the implementation of profiled connections with the depot based Royal Mail Fleet (Method 2).

2.6.1 Method 1: Flexibility services to DNOs from commercial EVs on domestic connections

British Gas vehicles charging at home were aggregated into Flexible Units (FUs) in order to provide turn-down services to the DNO. This method was extended to the depot-based vehicles of Royal Mail in order to study the differences between the two fleet types when it comes to flexibility provision. The British Gas home-based fleet was found to be very reliable in the delivery of flexibility services, over a one hour period and at specific times, due to its predictable pattern of charging load. The short and sharp load peaks at some depots limited the duration and volume of flexibility that could be reliably offered.

Other key findings included:

- Month (or further) ahead products should allow fleets to re-forecast their baseline in the run up to delivery to improve predictability/reliability of outcome
- Pricing incentives should be structured to reward good performance without disincentivising participation by some fleets. A range of products with different performance/reliability thresholds could be implemented to achieve this, with fleets with a higher probability of successful delivery attracting a higher price
- Automation is required in the tender, bidding, dispatch and settlement calculation processes to make provision by smaller assets cost effective
- Baselining establishes a normal level of load against which the delivery of flexibility is judged and rewarded. As EV demand fluctuates, establishing an accurate baseline can be difficult. Tests of several baselining methodologies highlighted the need to use recent data and demonstrated that the most accurate method varied and needs to be chosen based on fleet characteristics. Incentives should be used to prevent the occurrence of secondary peaks which could cause additional problems for the network.
- Trials suggest that between seven and 20% of depot charging costs could be covered by revenue from flexibility services and revenue of around £215 per vehicle per year could be received for home-based flexibility. However, whether this can be achieved depends on the DNO’s requirements for flexibility services, the electricity tariff and how this aligns with the depot’s charging schedule.

2.6.2 Method 2: Planning tools for depot energy modelling, optimisation with profiled network connections

The trial for this method involved the testing of profiled connections at nine Royal Mail depots. A suite of tools were developed as part of this method in order to guide depot customers through the process of assessing their requirements, requesting profiled connections and implementing smart charging to maintain the profile. This involved:

- A simple Site Electrification Planner, which uses minimal data to inform customers whether they are likely to be able to install CPs with their existing capacity
- The Site Planning Tool, which requires more inputs from the customer, demonstrates the potential benefits of smart charging and produces an example connection profile
- Revisions to UK Power Networks' connection planning tools in order to plan connections that vary at 30-minute granularity
- A depot optimisation system, into which customers can enter the constraints of the profiled connection in order to control the rate of charging in line with the profile. This system is explained further in Section 3.3. The optimisation system is also able to carry out other

functions, such as providing flexibility services (see Section 2.6.1) and optimising charging based on electricity tariff
- Monitoring systems to provide alerts when profiles are breached.

It is expected that many customers would not need to implement the full solution as the tools may show that electrification can be achieved without a connection upgrade.

While profiled connections were implemented successfully, a key finding was that they may be less suitable for locations where the EV load is relatively small, or the background load is particularly variable. To be successful, the controllable EV load must exceed the potential variation in background load, otherwise breaches may occur.

Other findings and recommendations included:
- Using smart charging to manage load in line with a profiled connection was shown to save some depots up to £95,000 on the cost of connection and up to 12 weeks in the time to connect
- A process to model the expected load flow (such as using UK Power Networks' Envision data), as a proxy for the substation data may be required if no monitoring is available, supplemented with half-hourly data and/or diversity modelling
- Planning systems need to have the capability to assess network loading at a half-hourly granularity, in order to assess the feasibility and benefit of a profiled connection
- The range of contracts should allow for dynamic profiled connections, that can be changed or activated at the request of DNOs to act as flexibility products
- A process to revise profiled connections is needed to allow changes in fleet operations during the life of the connection. A review is likely to be required approximately one month after implementation to ensure the EV load is in line with the forecast. Seasonal updates may also be required, in addition to ad hoc reviews in response to significant changes in fleet or depot operations. Integrated monitoring is required to provide the DNO with visibility of breaches, a method of communicating alerts to the provider is also required
- A method to police the profile, either through physical disconnection, economic penalties, or a combination of the two, must be agreed in the contract and implemented
- The site planning tool may deliver value without profiled connections, as it encourages customers to carefully consider the impact of EVs on their site load and demonstrates the benefits that can be achieved through smart charging.

3 Details of the work carried out

3.1 Project structure and governance

Optimise Prime was organised into seven workstreams to deliver the project:

- Three trial workstreams, WS1, WS2 and WS3 for the home, depot and mixed trials respectively
- A technology workstream, WS4, responsible for the project's IT platforms, development and flexibility work common to multiple trials
- A business modelling workstream, WS5, which carries out financial and behavioural modelling across the trials
- The reporting workstream, WS6, creating the project's deliverables and regular progress reports
- The project management workstream, WS7, responsible for overall management of Optimise Prime, in addition to knowledge exchange activities.

Hitachi was the project lead, responsible for overall management of the project, the development of systems to support the trials and the production of deliverables. UK Power Networks were the sponsoring network operator, they were responsible for oversight of the project, provided network expertise and developed systems and products to enable the trial of the methods. Scottish and Southern Electricity Networks were a DNO partner, providing additional insights to ensure the Methods are replicable across GB.

Centrica, Uber and Royal Mail were the fleet partners, contributing data from their operations and allowing the trials to take place amongst their drivers. Centrica also developed the technical solutions for WS1. Novuna Vehicle Solutions provided facilities for testing project solutions and gave access to their customers to widen the project's behavioural surveys.

The project board, consisting of representatives of all project partners, met quarterly to discuss project progress and make decisions regarding any major changes to the project plan. More frequent meetings took place between Hitachi and project partners to plan and monitor the execution of the trials. Monthly cyclical review meetings were held between Hitachi and UK Power Networks in addition to weekly status reporting. All project partners were involved in reviewing the project's Deliverables before publication. The project contracted Ricardo Energy and Environment as the independent reviewer of the Optimise Prime deliverables. Ricardo provided a report following the completion of each deliverable, allowing the project to address any deficiencies that were identified through future deliverables.

Within Hitachi a number of boards were set up to manage the project on a day-to-day basis including weekly meetings of the workstream leads, a monthly steering board and a quarterly executive board. A technical design authority oversaw the design of the project's IT solutions and took responsibility for data security.

3.2 Workstream 1 – The home charging trial

This section and the following sections detail the work carried out across the project's workstreams. Full details of the design and build of the project's infrastructure and solutions were detailed in Deliverables D2, D3 and Appendix 9 of Deliverable D7.

Workstream 1 collected data from British Gas EVs operating throughout the UK and delivered Method 1, *Flexibility services to DNOs from commercial EVs on domestic connections*. The number of British Gas EVs increased throughout the trial period, growing from approximately 300 to over 1,000.

3.2.1 The home charging solution

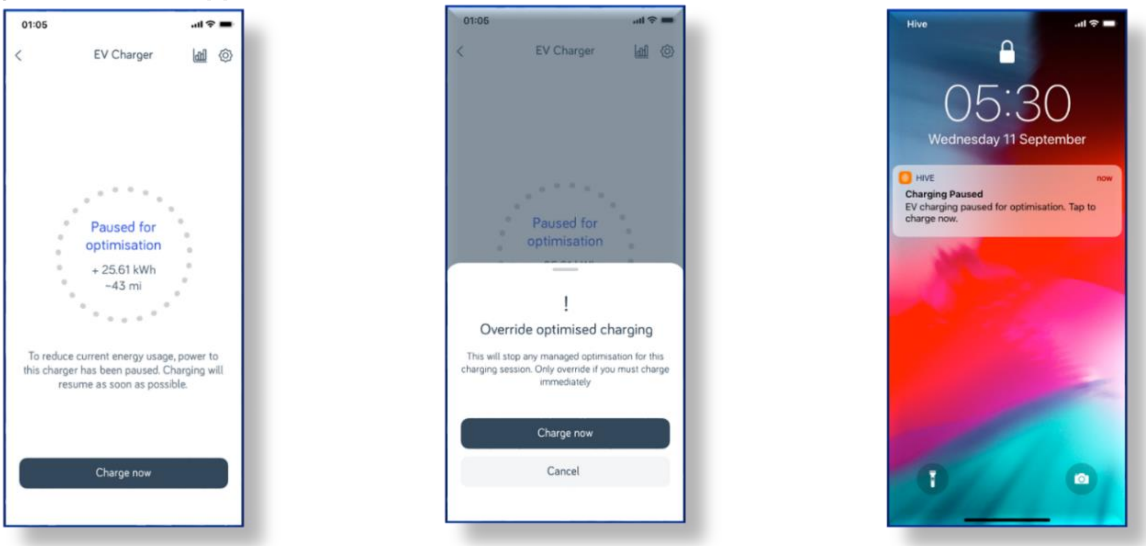
Following a survey of each site, Centrica installed CPs at the homes of around 90% of their British Gas EV drivers. The CPs were connected via a cellular service to Centrica's back-office system and flexibility service platform, allowing for the reporting of charge point (CP) usage and the receipt of control signals.

British Gas drivers could view the status of charging, and control some functions through a dedicated app.

The Centrica flexibility system was able to carry out a number of optimisation functions, including aggregating CPs into flexible units that could respond to flexibility requests, delaying charging until a specific time in line with predicted electricity prices and the calculation of reimbursements based on meter data and employees' electricity tariffs.

Drivers could use the app to view the status of the charge session (e.g., whether a charge was in progress or was being delayed) and were given the capability to override the smart charging and start charging immediately if required (Figure 1).

Figure 1 – Driver app notifications



Charging paused by the aggregator | Override option for emergencies | Real time notification

Drivers could also use a virtual fuel card functionality to utilise public CPs, however the project was not able to receive detailed data on these charging sessions.

3.2.2 Flexibility dispatch

UK Power Networks implemented upgrades to their cloud-based active network management (ANM) system, Strata, in order to run the Optimise Prime flexibility trials. Two products were defined for WS1 – day ahead (Product B) and intraday (Product C). For both of these products, a process was put in place to register the Flexible Unit (FU), to set up and test communications between the ANM and Flexibility Service Provider (FSP) systems.

Either UK Power Networks or Scottish and Southern Electricity Networks would issue in invite to tender by email in advance of each flexibility event. Centrica's system would then respond by sending an application programming interface (API) message detailing the scheduled/predicted demand of the FU the bid volume and price per MWh of turndown for each period where flexibility was being offered. Following gate closure, the ANM system would send a revised schedule to the FSP (Figure 2), setting the requested output for each period, effectively accepting or declining the offer for each period. This revised schedule was then implemented by the FSP system by controlling the charging load.

Figure 2 – Product C dispatch scheduled in UK Power Networks' ANM system

Start Time	Value (MW)	Start Time	Value (MW)	Start Time	Value (MW)	Start Time	Value (MW)
00:00	0.00	06:00	0.00	12:00	0.00	18:00	0.00
00:30	0.00	06:30	0.00	12:30	0.00	18:30	0.00
01:00	0.00	07:00	0.00	13:00	0.00	19:00	-0.38975
01:30	0.00	07:30	0.00	13:30	0.00	19:30	-0.38975
02:00	0.00	08:00	0.00	14:00	0.00	20:00	0.00
02:30	0.00	08:30	0.00	14:30	0.00	20:30	0.00
03:00	0.00	09:00	0.00	15:00	0.00	21:00	0.00
03:30	0.00	09:30	0.00	15:30	0.00	21:30	0.00
04:00	0.00	10:00	0.00	16:00	0.00	22:00	0.00
04:30	0.00	10:30	0.00	16:30	0.00	22:30	0.00
05:00	0.00	11:00	0.00	17:00	0.00	23:00	0.00
05:30	0.00	11:30	0.00	17:30	0.00	23:30	0.00

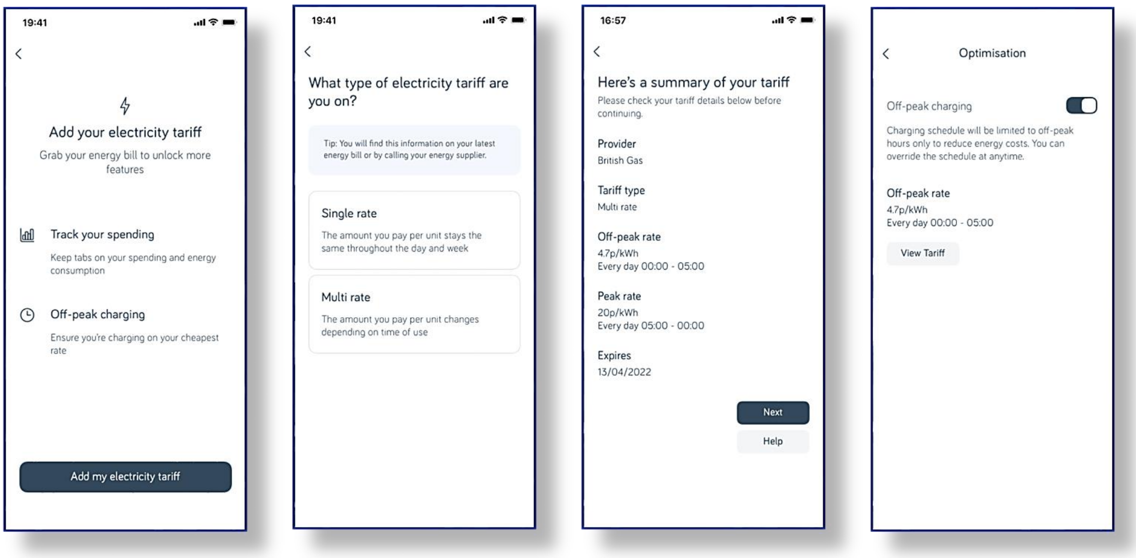
Following delivery, the FSP provided meter data from each FU to UK Power Networks, usually on a monthly basis. UK Power Networks then calculated the payment due to the FSP, based on the bid prices and delivery performance. A statement was sent to the FSP, who had a chance to query the calculation before payment was made. The settlement process was largely manual, due to the low number of participants, but could be automated for business-as-usual implementation.

3.2.3 Separation of domestic and commercial billing

Separation of domestic and commercial billing was achieved by Centrica through their home charging solution. This replaced a manual solution that was previously used by Centrica, but was not considered to be sufficiently scalable.

Meter readings were taken from chargers for each charging session and sent to the central management system. Drivers could set their electricity tariff using an app (Figure 3) and flag specific charging events as non-refundable using the app where they had used the CP to charge a non-work vehicle. Centrica also had the ability to compare charging events with telematics in order to reduce the risk of misuse of the system.

Figure 3 – Tariff management in Centrica driver app



Payments were made to each driver through the payroll system. Initially this was intended to be paid in arrears, however due to the potential cash-flow issues this could cause for drivers the system was altered to pay in advance, based on estimated usage. Full details of this solution were reported in Section 6 of Deliverable D5.

3.2.4 Provision of project data

Centrica provided data for analysis in a monthly batch process. This data included vehicle telematic events and charging events. Both of these datasets were published, in an anonymised form as part of Deliverable D6.

3.3 Workstream 2 – The depot charging trial

Workstream 2 collected data from Royal Mail vehicles working from nine depots in the London area. This workstream delivered Method 2, *planning tools for depot energy modelling, optimisation with profiled network connections*, and trialled the provision of flexibility services from depot-based fleets.

At the outset of the project, Royal Mail had already installed CPs at a number of depots, with 100 EVs located at delivery offices across the UK. Following the start of the project, further EVs were ordered for central London depots and additional CPs were procured and installed. This procurement activity was carried out by Royal Mail outside of the scope of the project.

3.3.1 The depot solution

The Optimise Prime smart charging system had to be installed as an overlay solution that could control both Royal Mail's existing and new CP infrastructure. As the exact details of the CPs to be installed were not known at the time of the bid, a system utilising an on-site charge point controller (CPC) was specified. The project tendered for the provision of this system and Nortech were the successful supplier, providing their Envoy remote terminal units within each of the depots (Figure 4) connected to a central iHost system. Each CPC was connected to the depot CPs via structured ethernet cabling, and to the iHost system via an ADSL connection and backup mobile connection. A test location was set up at Novuna's Trowbridge offices to allow for testing of systems before rolling out to live Royal Mail sites.

Figure 4 – Installation and testing of CPC infrastructure. Images courtesy of Nortech.

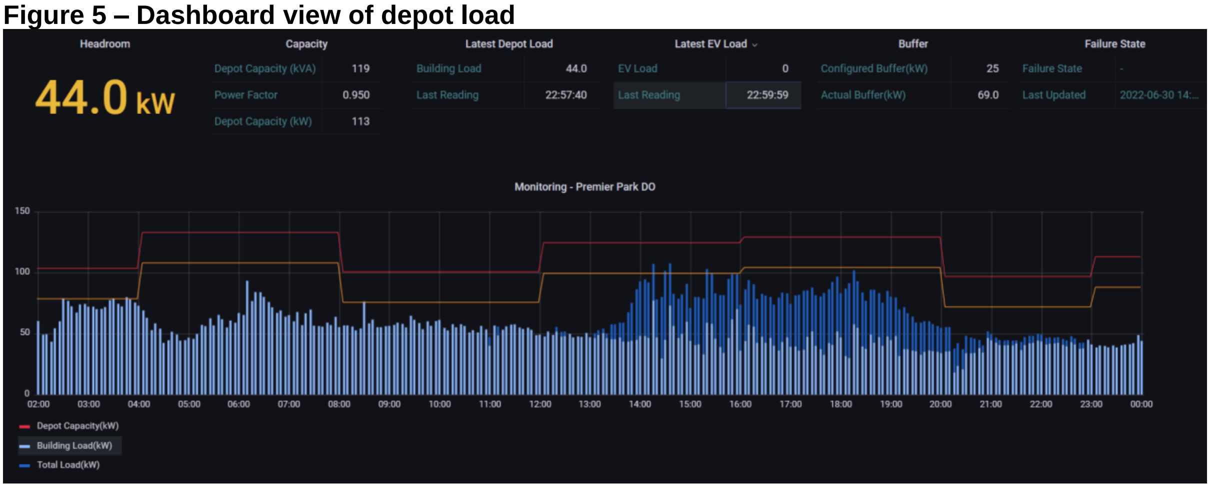
In addition to the monitoring and control of charging, monitoring of depot load was also required. This was achieved through Centrica's Panoramic Power monitoring solution. This system monitored load through non-invasive clamps on incoming supplies and provided data to Hitachi through Centrica's Power Radar system.

Following the completion of a first seven depots, it was decided to add a further two sites at Camden and Victoria through an over-the-air control system, where the Nortech iHost system directly interfaced with the charger back-office system Swarco eConnect. In addition to those two depots, this allowed the connection of CPs at one depot where it was not possible to run ethernet cabling. Implementing this solution required coordination between Nortech and Swarco, the CP back-office provider.

The Royal Mail EVs were already connected to telematics systems, with three systems in use for different vehicle types. Interfaces were built to collect data from these telematics systems, such as battery state of charge, mileage and locational information.

Hitachi developed a control solution, called the trial operational applications (TOA), which collected data from the on-site devices and the telematics services. A web-based interface allowed for the setup and monitoring of depots and vehicles, the creation of flexibility events, profiled connections, vehicle prioritisation and site load limits. Current and recent data could be viewed in real-time via a dashboard (Figure 5) and historical data was stored for later analysis.

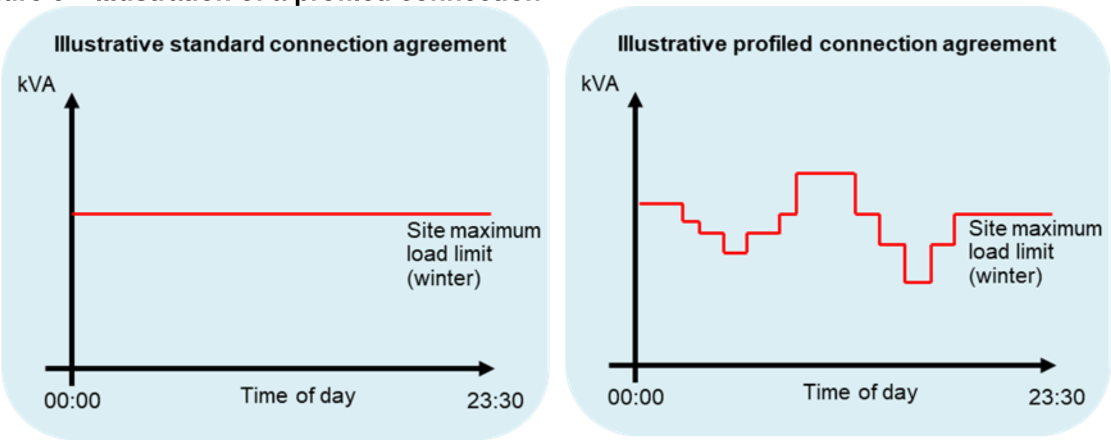
Figure 5 – Dashboard view of depot load



3.3.2 Setting, controlling and monitoring profiled connections

Profiled connections are a new type of flexibility product that is designed to allow sites to connect additional capacity to the network without triggering reinforcement by agreeing to limit load at specific times of day. The maximum load profile can be as granular as up to every 30 minutes, as shown in Figure 6. Sites can maintain this profile through active control of assets such as CPs. With profiled connections, fleets can potentially benefit from cheaper and quicker connection upgrades, because it may not be necessary to wait for physical upgrades to take place. Other network customers can also benefit, as the DNO is able to offer the connection while deferring reinforcement of shared network assets through more efficient use of existing network capacity.

Figure 6 – Illustration of a profiled connection



The Site Planning Tool was the first step in setting profiled connections. Initially a Microsoft Excel based tool was used to calculate an appropriate profile for each depot based on vehicle and shift data provided by Royal Mail. This tool was subsequently transitioned to a web-based version and updated based on trial learnings. The profile could be adapted based on constraint information provided by UK Power Networks. The tool is now publicly available on UK Power Networks' website.

UK Power Networks adapted their connections planning system in order to allow it to process profiled connection requests with up to 48 half-hourly variations within each day.

The profiled connection could be set for the site in the TOA user interface. The interface allowed a separate site load limit to be set for each half-hour of each day of the week. Profiled connections could be time-limited in line with the trial plan. When a profiled connection was in place, the TOA system took site electrical load readings and deducted current charging load to calculate the available headroom available for charging. A setpoint for each active CP was then calculated and implemented via iHost, subject to a minimum setpoint of 6A. This process was regularly repeated to account for changes in the profile, changes in background load and vehicle movements. A configurable buffer was set when calculating the available headroom for charging to account for any load fluctuations between optimisation cycles.

UK Power Networks installed a monitoring device at the majority of depots taking part in profiled connections, using EA Technology's VisNet® Hub. The hub provided regular meter readings to the ANM system. The profiled connection was entered into the ANM system, which was configured to send email alerts to the customer each time a breach of the profile was detected, and when a breach continued for a set period of time.

Over time the profiled connection for each site was adapted, based on analysis of performance of the site against the agreed profile.

3.3.3 Flexibility dispatch

Two flexibility products were offered in WS2 – Firm forward option (Product A) and day ahead (Product B).

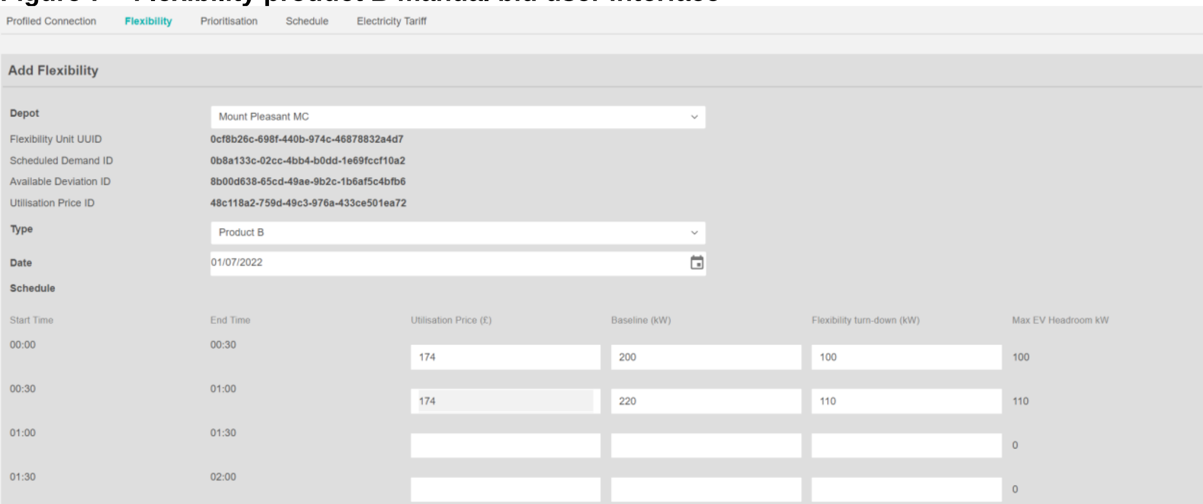
An initial registration process was put in place for both products, together with tests of communication between the FSP and ANM systems.

For the firm forward option, an invitation to tender was sent out by UK Power Networks, requesting bids for flexibility provision in specific time periods on each day of the week. A response to the bid was sent by email, indicating turn down offered, an availability price per MW per hour and a utilisation price per MWh for each window the FU could provide flexibility. UK Power Networks confirmed which bids had been accepted and set these flexibility events up in the ANM system. Hitachi, acting as the FSP, set up the events in the TOA system.

UK Power Networks sent dispatch messages via the API 15 minutes in advance of a requirement for flexibility provision, stating the turn down required from each FU. On receipt, the TOA system checked that the requests corresponded with a valid flexibility event and then implemented the turn down by sending revised setpoints to the active CPs. Setpoints were regularly re-calculated to account for vehicles arriving at and leaving the depots. On receipt of a zero turn down request, at the end of the flexibility window or when the agreed run-time was over, flexibility provision would end and the CP setpoints would be revised.

The day ahead product worked similarly to that implemented for WS1 (3.2.2) with schedules and bids entered into the TOA system and sent day ahead by API (Figure 7). A revised schedule received from the ANM system and implemented. The demand schedule could change each half hour during the flexibility window and CP setpoints were revised accordingly.

Figure 7 – Flexibility product B manual bid user interface



3.3.4 Provision of project data

As the control of charging took place on the project's IT platform, a wide range of data on charging, vehicles movements and flexibility events was available. A range of anonymised datasets on the WS2 trials were released as part of Deliverable D6.

3.4 Workstream 3 – The mixed charging trial

Workstream 3 collected anonymised trip data from Uber EVs operating in London. This data was used to estimate the impact of Uber EVs on charging infrastructure, and to estimate future demand on the network.

Uber shared a monthly file with Hitachi containing all trip events carried out by EVs on the Uber platform in London.

Because the data shared did not include charging events, Hitachi developed a methodology to estimate when and where on-shift public charging events occurred, based on a number of factors, including:

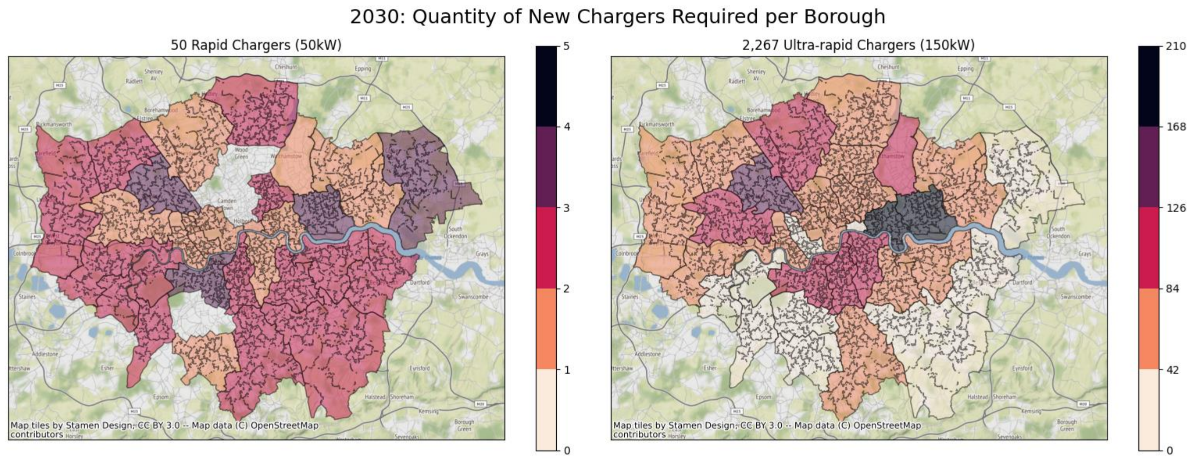
- The distance travelled by the vehicle
- The vehicle specification
- The length, start and end locations of gaps between trips in the data
- The location and speed of public charging in London, supplied by Zap-Map.

Home locations of drivers were also estimated at lower layer super output area (LSOA) level, based on common shift start and end locations. Off shift charging, based on distance travelled, vehicle specification, any on-shift charging, and the shift end time, was allocated to these locations. Data on prevalence of off-street parking was used to inform how much of this demand would require public infrastructure.

Visualisations were produced comparing peaks in Uber charging demand at LSOA level with available headroom at distribution substations. A borough level summary of this data was released as part of Deliverable D6.

In addition to analysis of the current Uber charging activity, forecasts were made based on Uber's borough-level forecasts for future EV adoption and charging behaviours seen in the trials. Other changes, such as increasing battery capacity, were also considered. The predicted volume of charging was calculated and from this, the requirement for charging infrastructure was calculated across two scenarios, based on a mix of fast and ultra-rapid charging and use of ultra-rapid charging only (Figure 8).

Figure 8 – Visualisation of CP requirements in Greater London produced in WS3



The network related cost to install public charging infrastructure was also assessed by UK Power Networks at 50 locations identified by Uber as requiring the installation of CPs to support the adoption of EVs by drivers.

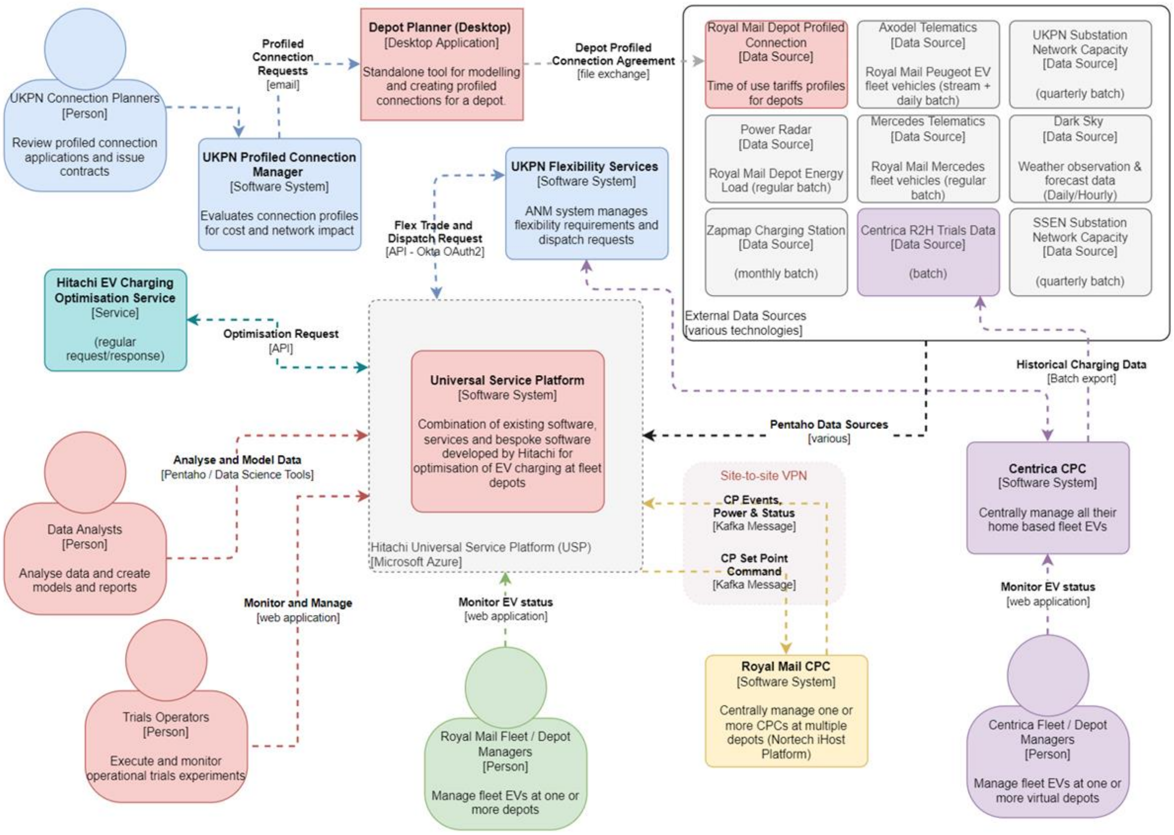
3.5 Solution architecture

In order to deliver the trials a number of solutions were put in place, as detailed in the previous sections. Figure 9 illustrates the architecture of the systems that enabled these solutions, centred on the project's Universal Service Platform (USP), the project's main data storage and hosting environment, developed by Hitachi and hosted on Microsoft Azure.

The USP securely interfaced with a range of data sources and other systems in order to collect the data needed for analysis and to carry out the optimisations.

In addition to the data ingestion elements, the USP platform provided the development and hosting environment for the depot applications delivered in WS2 and supported a number of data science tools that were used by project data scientists to compile the analysis contained within the project's deliverables.

Figure 9 – Optimise Prime solution architecture



3.6 Network impact modelling

Optimise Prime collaborated with Element Energy, who support UK Power Networks with their Strategic Forecasting System (SFS), to model network impacts based on trial data.

The first phase of this work, detailed in Deliverable D5, used preliminary EV charging behavioural datasets for Royal Mail and British Gas fleet vans and Uber PHVs to create a first order estimate of the impacts of EVs, and of smart charging on future network load and reinforcement requirement.

In the second phase, modifications were made to the SFS to provide more granular modelling of fleet types (specifically, allowing the Royal Mail and British Gas charging profiles to be applied to specific type of vans). Additional data from the trials was also entered to compare the impact of different charging regimes:

- Unmanaged charging
- Time-of-use smart charging
- Provision of flexibility
- Profiled connections.

These charging regimes were entered into the SFS in the form of plug-in time profiles derived from recorded:

- Charging times
- Daily mileage
- Charging speeds
- Charging frequency
- Charging location types.

Where information was not gathered in the trials (for example a smart charging profile for PHVs), the default SFS data was used.

This analysis applied the Optimise Prime results to all vans and PHVs in the UK Power Networks footprint to understand how these vehicles are likely to contribute to peak load at substations across UK Power Networks' area up to 2050. This impact was quantified in terms of required investment to replace network assets. Seven scenarios were run, with different combinations of the charging regimes, in order to identify the impact of each method on network investment. These scenarios model a case where all fleets would have the exact same characteristics as the Royal Mail, British Gas and Uber fleets.

3.7 Total Cost of Ownership analysis

An understanding of the economics of fleet electrification is useful for fleets, DNOs and other stakeholders, as the cost-benefit analysis impacts upon how quickly fleets will electrify. The analysis can also help put network-related costs in context with other costs involved in electrification.

The TCO analysis carried out as part of Optimise Prime compared the cost of acquiring and operating an ICEV fleet against an electric fleet over its lifetime and is a key component of the business case for transition to EVs for most organisations. The purpose of TCO modelling was to demonstrate a like for like, complete cost comparison, and to explore the influence of historical and future changes in the key variables.

While at the outset of Optimise Prime it was expected that in most scenarios an EV fleet TCO should be at least at parity with an ICEV fleet, if not lower, changes to external factors over the course of the project have made this picture more nuanced. The TCO models presented in Appendix 4 of Deliverable D7 explore the impacts of such changes, including increases of electricity and fuel prices, vehicle costs, as well as changes to government policies. The influence of the methods trialled under Optimise Prime were also considered.

3.8 Behavioural studies

Financial motivators are not the only value consideration when fleets choose to switch their fleets to EV. Environmental and reputational benefits are a key consideration, as is ensuring that business can carry on as usual and that drivers are happy with their new working environment. Optimise Prime explored behavioural aspects of the transition to EV by conducting over 3,000 surveys of vehicle drivers and fleet managers. The surveys included questions on adoption, barriers and enablers, user experience and changes in this experience over time, the impact of power network constraints and the organisational decision-making processes. The survey process was repeated during the project to identify trends. The results of the survey not only raise learning points for fleets looking to electrify, but also factors that may accelerate or slow the overall transition and the resultant impact on the distribution network. The full results can be found in Appendix 5 of Deliverable D7.

4 The outcomes of the project

4.1 Key findings from the project

The Optimise Prime trial activity resulted in multiple learnings that will be of use to DNOs adapting to the growth of EV demand, and fleet operators converting their fleets to EVs. This section presents the highlights from the project by use case and the main findings relating to the two project methods. More detailed analysis of the trial results and recommendations for implementation of the methods can be found in Deliverable D7 and its appendices.

4.1.1 WS1 – Return-to-Home Trials

- Unmanaged, home-based fleets will create **concentrated load peaks starting at around 17:00** due to the timing of the end of shifts coinciding with network peaks
- **Smart charging can be very effective** to change load patterns, but leads to significant **secondary peaks on the network** overnight. Incentives to drive the smart charging behaviour should be considered to reduce the impact of this behavioural change on the network
- The British Gas home-based fleet was found to be **very reliable in the delivery of flexibility services**, over a one hour period, due to its predictable pattern of load
- **Winter EV energy requirements** are approximately **30% higher** than in the summer
- The proportion of the home-based fleet that relies on public infrastructure has increased throughout the trial, because not all drivers can charge at their homes. It is estimated that **up to 60% of the British Gas fleet may need to use public infrastructure** once electrification is complete.

4.1.2 WS2 – Depot Trials

- **Load profiles are depot specific** and can change seasonally, with **two main peaks appearing at 14:00 and 19:00**, which follow the depot delivery schedules. More rural Royal Mail depots are likely to see their demand peak in the afternoon
- The short and sharp load peaks at some depots limit the **duration (up to three hours)** and **volume of flexibility (up to 25% of the depot's charging capacity)** that can be offered. Flexibility products should **incentivise participation from fleets** that can offer flexibility **very reliably and** fleets that are **less reliable**, as well as different volumes of flexibility, to maximise access to controllable load at the best possible price
- **Factors impacting reliability** of flexibility services include the size of the depot, the CP to EV ratio, daily EV mileages and operational processes
- Using **smart charging** to manage load in line with a profiled connection was shown to **save some depots up to £95,000** on the cost of connection **and up to 12 weeks** in the time to connect
- **Profiled connections can be successfully implemented**, but **EV load must be the dominant load** in the depot for its control to reliably ensure compliance.

4.1.3 WS3 – Mixed Trials

- Most **(77%) demand from PHVs occurred off-shift**, with **plug-ins peaking at about 20:00**, but continuing through the night - later than other fleets
- **Future demand from PHVs is likely to shift further towards off-shift charging** close to home, as vehicles with larger batteries are able to complete full shifts on one charge, further reducing the proportion of on-shift charging
- By 2025 it is expected that Uber EVs will require 497 GWh of energy per year in Greater London, compared to around 150 GWh in 2023, creating a peak of 69MW from off-shift charging. To service this, **33,539 fast CPs may be required** if drivers opt for overnight fast charging.

- Overall, **there is sufficient network capacity to accommodate this demand**, however there may be requirements for network upgrades in specific areas, such as suburban areas with clusters of drivers, or if rapid charging hubs are specified to meet demands.

4.2 Findings specific to the two project methods

4.2.1 Flexibility Services (including home and depot based services)

The Optimise Prime flexibility trials were run throughout the trial year and involved the provision by the WS1 and WS2 fleets of three different flexibility products. Provision of flexibility services from homes and depots are considered together in this section due to the similarity in the services offered – differences between home and depot flexibility are highlighted where necessary.

Overall, the Optimise Prime trials demonstrated the ability of EV fleets to provide flexibility services to the DNO. Key learnings from this include:

- Fleets can offer **flexibility at specific times**, dependent on when their shifts end and this varies by fleet. While in most cases this was in line with the network peak, some depots had earlier or later peak loads
- Larger **aggregated** groups of vehicles can provide more reliable flexibility services when offering the same percentage of total load turn down. This is because there is a degree of unpredictability in the timing of charging for a specific vehicle, and this is averaged out in a larger group. However, in some circumstances the DNO may gain significant benefit from a smaller group of vehicles close to where the network is constrained, even if the turndown results may be less reliable
- Vehicle **charging profiles can vary over time**, both due to varying efficiency and changes in shift end times. This impacts the charging load and therefore the quantum of flexibility that can be offered
- There is a **limit to the duration of successful flexibility response** (one to three hours) that EVs can provide – this is due to two factors:
    - The time available to charge vehicles without impacting operations is limited. This primarily impacts vehicles that travel longer distances or are charged infrequently.
    - The limited duration of the usual charging profile, due to lower mileages (although depots may be able to maintain a low load, this may not be low compared to usual demand). This is especially true of fleets that travel shorter distances
- The process of offering flexibility needs to be **simple and automated**, from the fleet perspective, otherwise the cost of providing the service may outstrip the revenues available
- **Baselining** demand can be particularly time intensive and, due to the factors mentioned above, may not always be accurate. A shorter baselining period is likely to be more accurate
- Flexibility services were trialled alongside **profiled connections**. The outcomes from these trials are discussed in Section 4.2.2.

There are many factors which affect the delivery performance during a flexibility event, with the ability to forecast accurately relying on the efficiency and consistency of depot operations.

Key factors identified as impacting the success of flexibility events included:

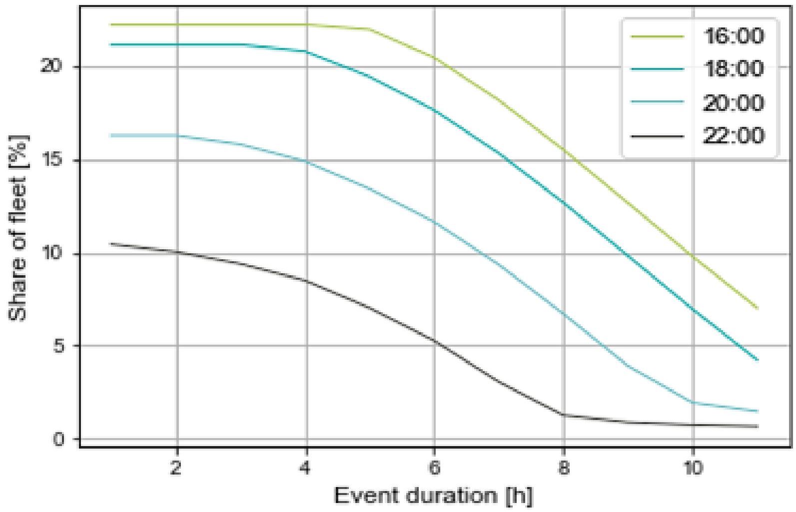
The short and sharp load peaks at some depots limit the duration and volume of flexibility that can be offered – the home trial fleet was more predictable and charged for longer periods

In an unmanaged scenario, the Royal Mail load curve peak is short and sharp so the peak turndown is available for a limited time window (less than three hours). This differs from many other load types that take part in demand response.

- The timing of this peak can vary over time as schedules react to changing workloads across seasons, making long-term prediction difficult
- The vehicles can only provide flexibility when they would normally be charging. This reduces the ability of depots to participate in products that require a long period of availability. The flexibility window required by the DNO may not align with this period depending on the specific depot and local constraints
- The flexibility window required by the DNO may occur when the vehicles are normally plugging in or finishing charging. This period of load change is especially difficult to predict, reducing the amount of flexibility that can be offered by the participant
- Where two flexibility events were tested in the same day, or events were longer than three hours, the amount of flexibility that could be offered consistently over the period was low, due to the short charging durations

The British Gas fleet generally travelled further each day than the Royal Mail EVs and plugged in at a relatively consistent time each evening. Analysis has shown that over 20% of the fleet can provide flexibility for up to four hours if the event starts at 16:00. The longer and later the event falls, the fewer vehicles will be able to respond because the EVs need time to be charged for the next day’s work, as shown in Figure 10.

Figure 10 – Share of British Gas fleet able to provide flexibility by request time and duration



There is significant variation between weekdays and weekend loads and between individual days of the week

While there are general trends, the size and timing of peaks can vary significantly between and across weekdays and weekend days. For example, at Royal Mail depots, load on Sundays was significantly lower than load on Saturdays. Amongst British Gas drivers, load on Fridays was lower than Monday to Thursday, as drivers had two days to charge before their Monday shift. This variation limits the amount that can be offered in products that require the same capacity to be bid on each day, or every working/non-working day.

Businesses will be conscious of how flexibility provision may create operational risk, and may limit flexibility participation as mitigation

Some limitations that were put in place in order to reduce risks to project partners reduced the amount of flexibility that could be offered and delivered in the trials:

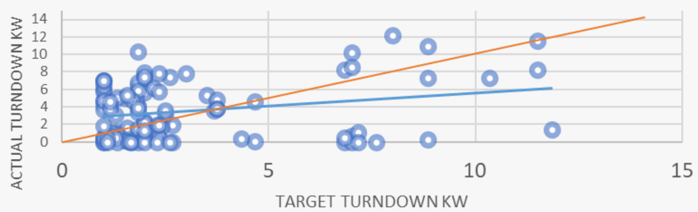
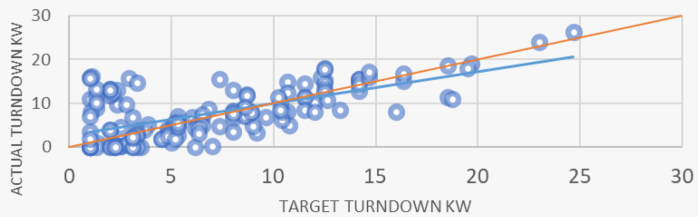
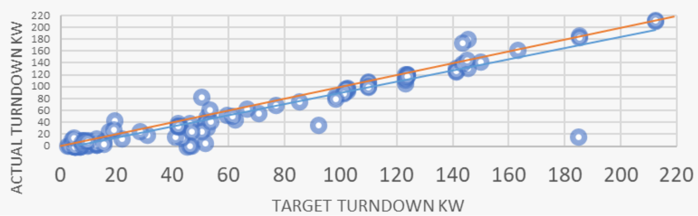
- As a result of the minimum charge rate at Royal Mail depots, where flexibility events started several hours after a shift finished, the turndown that could be offered and delivered was significantly lower because many of the EVs would have reached a high state-of-charge (SoC), or finished charging, reducing the ability to offer load turndown
- The amount of flexibility that could be offered from each vehicle was also reduced by 1.4kW compared to a fleet that could turn off completely
- For the final flexibility trial, the Royal Mail CPs at one depot were turned off fully and the amount of flexibility turndown increased, roughly doubling the response.

In a business-as-usual scenario, other risk mitigations could be considered which have less impact on ability to shift load. For example, by limiting the duration of flexibility events (as was the case in the WS1 trial), implementing a manual failsafe to reset charging speeds or as a result of the fleet becoming confident of the system's reliability.

The size of the depot impacts upon the reliability of demand response provision

The size of the depot was a significant factor affecting how much flexibility could be offered and how reliably it could be provided. The large depot (>100 EVs) was more reliable than the small depots (25 EVs) because small variations in day-to-day routines had a proportionally smaller effect on the total load. Figure 11 shows how the larger depot was able to align delivery more closely to the target turndown amount, while also turning down a greater proportion of its load.

Figure 11 – Flexibility results by depot size

Depot	Actual vs target turndown	Turndown as a % of unmanaged load
Small		**42%** on average
Medium		**50%** on average
Large		**63%** on average

CP to vehicle ratio has an impact on the predictability of flexible load

The ratio of vehicles to CPs varied between locations – homes and some depots had a 1:1 relationship, allowing vehicles to be charged every day. Other depots had up to three vehicles per CP, resulting in each vehicle charging less frequently. While this resulted in higher charger utilisation, it also made it more complex to predict when and for how long a particular vehicle would charge.

Operational procedures at specific depots impacted the timing and predictability of load

There was no standard procedure for charging vehicles at Royal Mail sites resulting in significant variation in load across sites. While most sites plugged in vehicles when they returned from shifts, one site often charged its vans early in the morning before shifts began. Ad hoc charging also took place during the day at unpredictable times. Other factors, such as physical access to parking spaces impacted the number of vehicles able to charge at any time.

- **Specific to the trial,** Hitachi controlled the charging of Royal Mail's EVs via a system which relied on identification of vehicles via radio-frequency identification (RFID) cards. To maintain Royal Mail's operations, only recognised vehicles were involved in the optimisation and flexibility provision. At times unknown RFID cards were introduced, resulting in CP load that could not be controlled and EV load increasing during the flexibility event. This was resolved as the trials progressed through the recognition and registering of unknown RFID cards.

A trade-off needs to be made between the value of more reliable flexibility, versus a greater volume of flexibility

GB DNOs are committed to using demand side response to reduce the need for network reinforcement as part of their flexibility first approach. As a result, it is necessary to encourage the provision of more flexibility services from a wider range of sources, such as EVs.

The Optimise Prime trials have shown that there is a clear difference in the reliability of flexibility services provided by different EV fleets, due to the variability of the load. If flexibility providers are not paid for flexibility provided due to poor performance they will likely take a conservative approach to making bids for services, based on a worst-case scenario. This would limit the volume offered and supplied to the DNO.

Conversely, if the DNO were to value under-delivery, there would be less certainty of the extent to which flexibility could be relied upon, so a greater quantity would need to be procured.

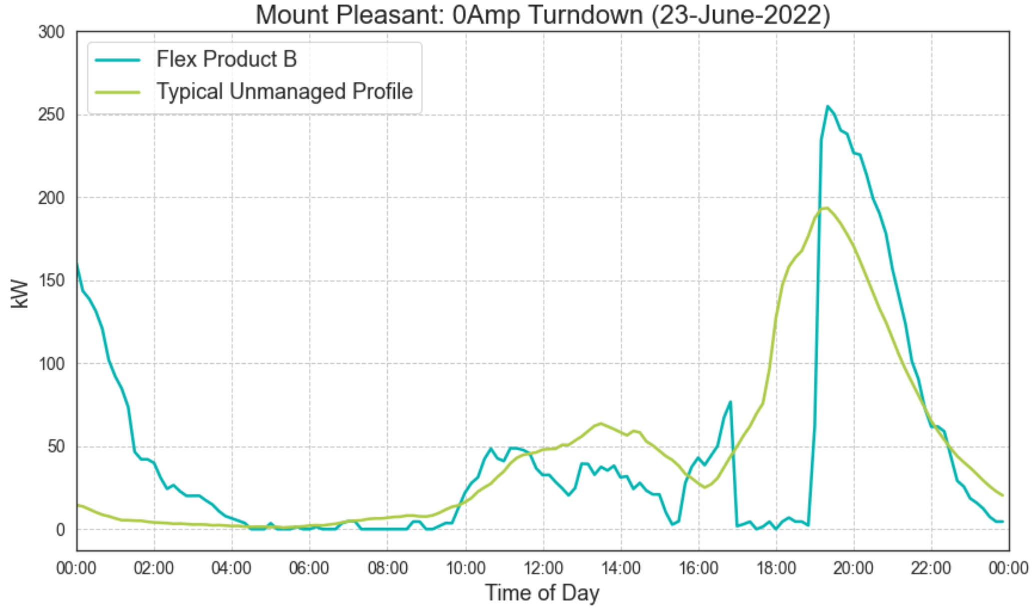
To encourage providers from a wider range of sources, different flexibility products with different reliability requirements need to be offered. The price of flexibility can be altered relative to the reliability to offset the requirement to buy more capacity and ensure value for the DNO.

A secondary peak can appear at the end of a flexibility event and should be mitigated. This peak is driven by the magnitude of the demand response.

The Optimise Prime trials have shown that shifting demand through provision of flexibility services can produce a new peak once the flexibility event has ended, similar to the secondary peak from smart charging discussed in Section 4.1.1, and shown in Figure 12. The size of this peak is driven by the amount of flexibility that has been delivered.

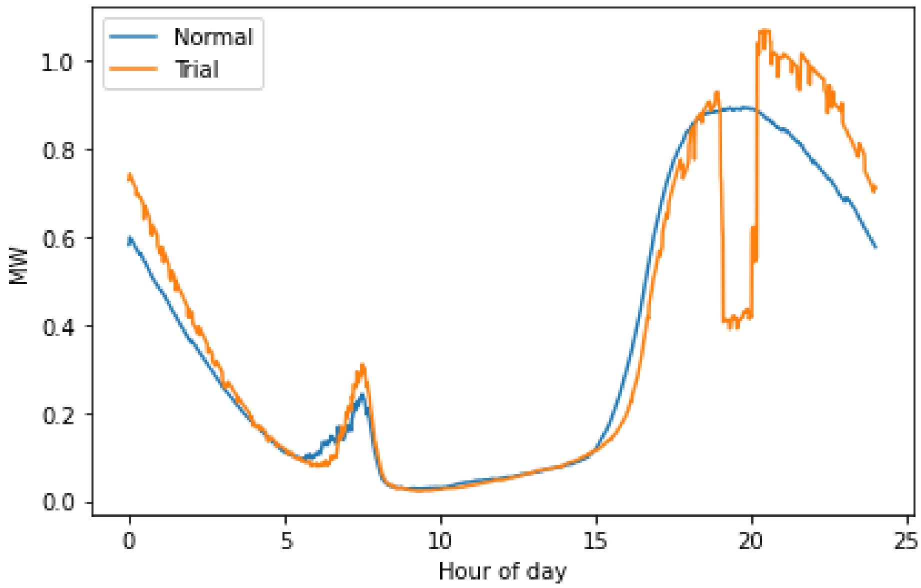
In the Royal Mail trials, where a minimum charging level of 6A was implemented, the new peak was often lower than the peak that was being avoided, as some vehicles will have completed charging during the flexibility event. When 100% of load was turned down the resultant secondary peak was 32% higher than the usual daily peak, as it resulted in all vehicles charging simultaneously.

Figure 12 – Full turn down of Mount Pleasant Depot and resulting secondary peak



Across the British Gas fleet, where around 50% of the fleet was turned down at any one time, the resultant secondary peak was 12% higher than the unmanaged peak, as shown in Figure 13.

Figure 13 – Flexibility trial vs normal charging behaviour in British Gas fleet



The settlement process needs to reflect the type and reliability of flexibility being provided

Settlement and baselining methodologies can have a significant impact on how delivered flexibility is measured and how providers are rewarded. The settlement process, which estimates how much flexibility has been delivered, must be carefully considered.

For example, when load is ramping up or down naturally, baselining against the previous half-hour period will often give a misleading result. The load shapes from the EV fleets show that this is generally the case with unmanaged charging – there is relatively little time when the load is stable. Five different baseline techniques have been compared based on trial data in order to identify the considerations when deciding on settlement methodology, as shown in Table 4.

Table 4 – Baseline methodologies compared using trial data

Baseline	Methodology
Optimise Prime Baseline Used by Hitachi to make bids	- Two to four weeks of data - Only includes days when a site is not providing flexibility services or any other charging suppression methods - Each day of the week treated separately - 30-minute mean kW per charger and per depot
60-day Baseline Using as much data as possible	- 60 days of data - Days when the site is not providing flexibility service - Days of the week combined to weekdays and weekends - 30-minute mean kW per charger and per depot
2 weeks baseline (average of 2 of the same day)	- Average of the last two weeks of data where the site is not providing flexibility services or any other charging suppression methods - Each day of the week treated separately - 30-minute mean kW per charger and per depot
UK Power Networks Baseline Used to calculate settlements	- Five qualifying days (five most recent weekdays or weekends) - Days when the site is not providing flexibility service - Days of the week combined to weekdays and weekends - 30-minute mean kW per charger and per depot
Adjusted Baseline Based on B376 BL01	- Up to 10 weekdays and four non-working days - Days when the site is not providing flexibility service - Days of the week combined to weekdays and weekends - 30-minute mean kW per charger and per depot (over all available data for weekdays and over middle two days for non-working days) - Adjusting the baseline with metered data over the three-hour period up until one hour ahead of the relevant Settlement Period when the service starts to deliver.

Table 5 shows the outcome of the comparison of the different methods, showing the average difference, in percentage, between the forecast and actual load for four depots at a specific time. Positive figures represent an over-estimation and negative figures an under estimation.

Table 5 – Outcome of analysis of settlement methodologies

Depot	Day	Average load 18:00-20:00 [kW]	Optimise Prime baseline, average diff [%]	60-day baseline, average diff [%]	2 weeks baseline, average diff [%]	UK Power Networks baseline, average diff [%]	Adjusted baseline, average diff [%]
1	Weekday	24.7	-8%	-8%	-45%	-12%	11%
2	Weekday	167.9	-6%	-7%	-46%	-39%	-17%
3	Weekday	18.4	40%	38%	-16%	-6%	109%
4	Weekday	53.0	-6%	-6%	-57%	-34%	3%
1	Weekend	8.4	-17%	-10%	2%	-34%	-32%
2	Weekend	8.5	-16%	3%	-12%	-31%	-82%
3	Weekend	12.9	-15%	-21%	20%	-26%	10%
4	Weekend	31.1	-73%	-73%	-6%	-56%	-109%
Mean absolute differential			**23%**	**21%**	**20%**	**30%**	**47%**

While the analysis showed that there was a degree of error in all of the baselining methodologies, the following observations are made based on the results:

- Data used for evaluation should be as close to the event as possible, to avoid any effects of seasonal variation

- Evaluation period should have the same characteristics that are expected during the event (no/same charging suppression methods)
- Each day of the week should be treated separately
- Two or more occurrences of each day of the week are recommended (two or more Mondays, two or more Tuesdays, etc)
- In-day adjustments, where the baseline is increased or decreased based on load earlier in the day, may not be suitable for situations where there are variations in plug-in time (which occurred in the Royal Mail trials), rather than the magnitude of load, because the load when vehicles are charging is not relative to load earlier in the day.

4.2.2 Planning tools for depot energy modelling, optimisation with profiled network connections.

Profiled connections were initially trialled at all nine Royal Mail depots. It quickly became clear that not all depots were suitable for this type of connection, because the EV load was not able to counteract large changes in background demand. Initial load profiles calculated based on telematics data were also found not to be fully accurate in estimating the timing of EV load, because EVs did not always plug in as soon as they returned to the depot. In subsequent trials, profiled connections focussed on depots with a greater proportion of controllable load and profiles were re-calculated, based on the load that had been observed at the site.

This resulted in a greatly reduced frequency and size of breaches, with an average breach size of 6.06kW (compared with a profile that averaged approximately 92kVA). Where breaches of the connection did occur, they were generally short in duration:

- 50% breaches lasted for no longer than one to two minutes
- 75% breaches lasted for no longer than four minutes
- There were very few breaches lasting longer than 10 minutes.

Where larger breaches, relative to the agreed profile, did occur, they were predominantly at times when EVs were not charging, such as late on Sunday nights or early on weekday mornings.

When setting the profiled connection, the DNO needs to consider whether there is a maximum size, frequency or length of breach that can be tolerated without causing disruption to other customers.

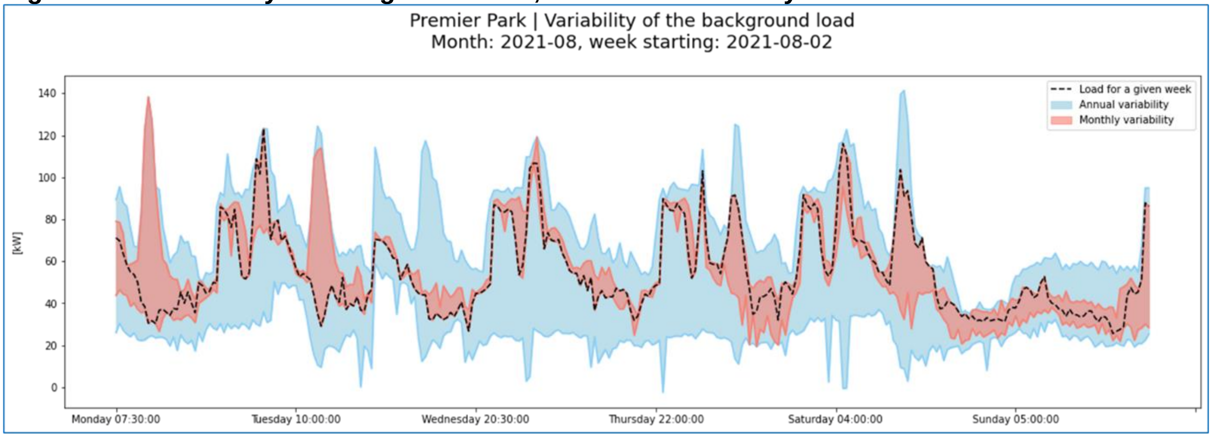
A further revision of the profiles, based on additional data gathered, was made in May 2022. This resulted in a significantly reduced breach rate: each breach averaging 2kW and lasting one and a half minutes, with the longest breaches much reduced.

Key insights from the trial of profiled connections include:

EV load must be the dominant load in the depot for the EV to be used to control load and to reliably ensure compliance with a profiled connection

The profiled connection trials showed that if the EV load was less than 50% of the variation of background depot load, controlling the EV load was irrelevant: the profile would eventually be breached unless the profile was set with sufficient headroom to accommodate the variability in background load, in which case no throttling of EV charging load would occur. Background load at sites was found to be extremely variable, as shown in Figure 14.

Figure 14 – Variability of background load, week vs month vs year



Therefore, for it to be possible for control of EV load to keep a site in line with a profiled connection, the site must adhere to a specific set of characteristics. The difference between the maximum building load (BL) (with a 10% margin for error added) and the minimum building load, over a forecasting period of at least two months of building load, must be less than the EV load:

$$EV\ Load < (Max(BL) * 1.1) - Min(BL)$$

While profiled connections were initially trialled at all sites, it was found that the majority of the Royal Mail depots did not meet this test, having a relatively high and variable background load. One site, with relatively high peak EV demand was selected as best meeting these requirements and trials of profiled connections were focused on this site.

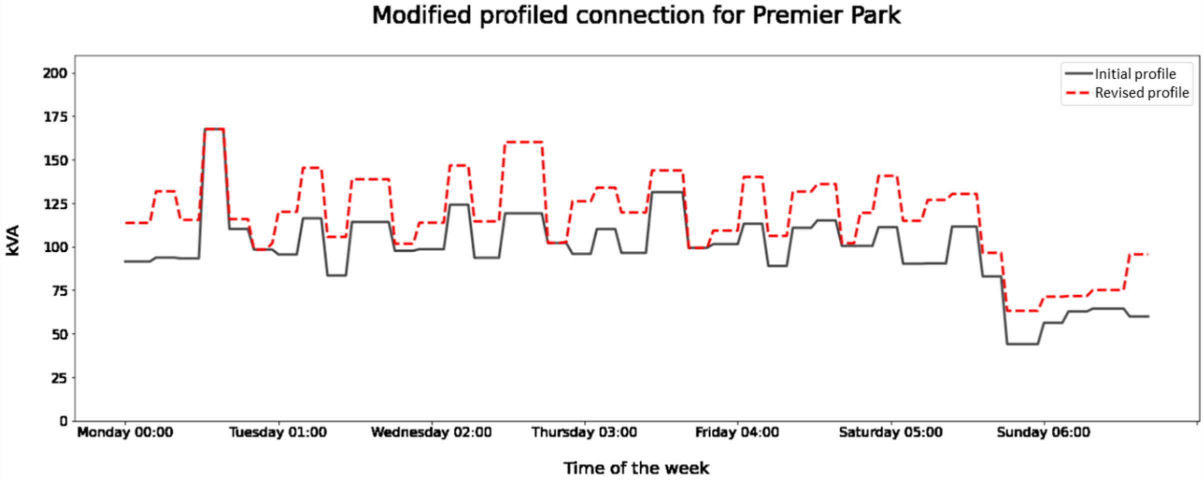
In short, the EV load must be the dominant load in the depot for a profiled connection to affect EV charging behaviour and not result in profile breaches.

While ICEV schedules can be used to calculate total charging load, they are not sufficient to predict exactly when charging will take place

The initial trials established charging profiles based on the ICEV schedules (which have been seen to be a good proxy for EV schedules) where an assumption was made that when an EV returns to the depot, it will be charged immediately. This, together with the variation in background load, resulted in significant breaches – in the most extreme case this resulted in a profile being breached by up to 28%, 17% of the time, while one depot recorded a breach of 72% of the profile. Over time, such poor performance may cause infrastructure to fail or reduce its operating life expectancy.

The profiles applied to each depot were refined three times, based on more EV charging data becoming available, to the point where very few breaches were recorded. To achieve this, the profile had to be increased at specific times based on observed load, as shown in Figure 15.

Figure 15 – Modified profiled connection at Premier Park over a week

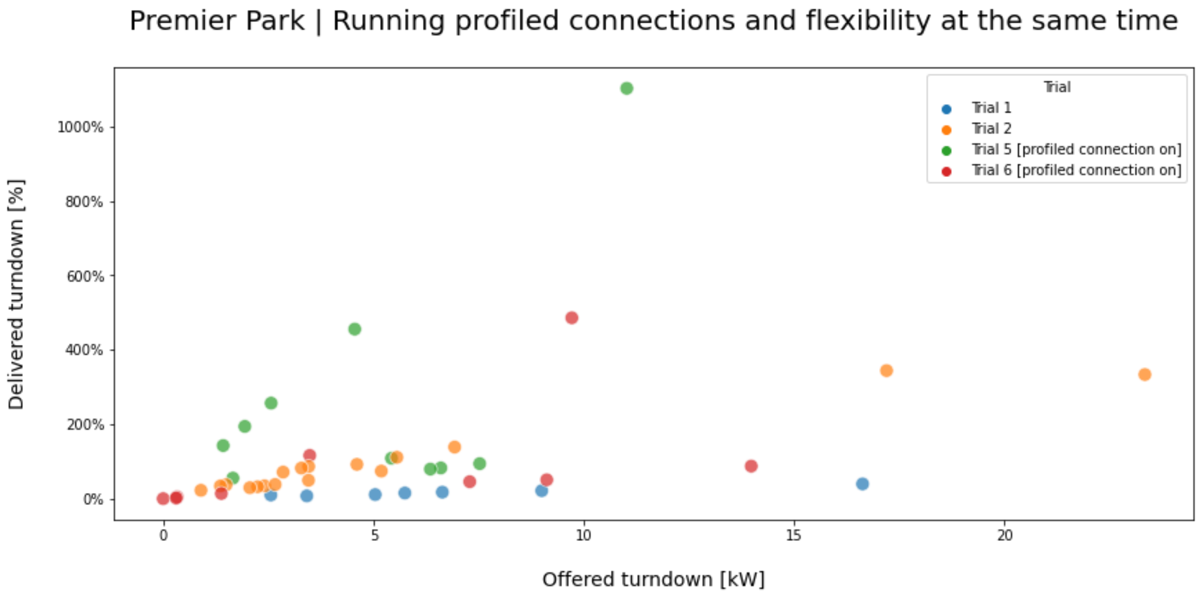


Profiled connections can be combined with flexibility services, but the profile may limit the response, and will need to have sufficient capacity for the provider to flex back up

Flexibility services were offered at Premier Park with and without a profiled connection being enabled. Figure 16 shows the result from these trials. For the trials where flexibility was offered on top of profiled connections, performance against the bid amount was not significantly worse than in trials without profiled connections.

The presence of a profiled connection can reduce the size of the bid that can be made, either because of properties of the site's load, the profile supressing load at the time flexibility is required or there being insufficient space in the profile to shift the load. This example does however show that there are scenarios when stacking the methods is possible.

Figure 16 – Flexibility results with profiled connections



5 Performance compared to the original project aims, objectives and deliverables

5.1 Aims

Optimise Prime set out several aims in the original project proposal in order to enable the transition of fleets to EVs while minimising the impact on electricity distribution networks. Table 6 outlines these aims and explains how they have been met by the project. Links to further information are provided where necessary.

Table 6 – Aims of Optimise Prime

Aim	Outcome
To be the first of its kind	The project team are aware of no other project involving commercial EVs that has achieved the scale of Optimise Prime and used that scale to trial solutions for distribution network operators.
To pave the way to the development of cost-effective strategies to minimise the impact of commercial electric vehicles (EVs) on the distribution network	Two methods with this aim were trialled, flexibility and profiled connections. Details of the findings from this work can be found in Section 4, and recommendations for future implementation were expanded upon in Deliverable D7.
Understand the impact of a wide range of variables, including different network constraints, typical mileage and driving style, traffic characteristics, location (urban, suburban, rural) and availability of public "top-up" charging.	The project has run trials at a range of home and depot locations and has reported on the challenges of implementing solutions at different types of sites. The operational analysis in Deliverable D7, Appendix 2 contains a wealth of information on how mileage and network impact vary based on a wide range of fleet characteristics.
Deliver invaluable insights through the use of data-driven forecasting tools designed to allow networks to proactively plan upgrades	Forecasts were made based on projected growth of the Royal Mail, British Gas and Uber fleets, considering the impact of the project methods on the distribution network. In WS3, the project created forecasts of how the growth in the Uber fleet will impact on both load and the amount of infrastructure needed across London for the charging of PHVs. Details of these forecasts can be found in Deliverable D7.
Develop detailed understanding of the amount of flexibility that commercial EVs can provide to the network through smart charging	The amount of flexibility that could be delivered from the trial fleets was quantified and the variables limiting flexibility provision were analysed. Details can be found in Deliverable D7 Appendix 1.
Develop a site planning tool that will allow organisations to request profiled connections from the DNO	The site planning tool has been developed and can be found on UK Power Networks' website.
Involve 2,000-3,000 vehicles	Over 8,000 vehicles were involved in the trials.
Robustly test different approaches to reducing the impact of vehicle electrification, in advance of mass adoption throughout the 2020s.	The two project methods were tested multiple times over the period of a year, allowing improvements and recommendations to be made to aid implementation. Details can be found in Deliverable D7 Appendix 1.
Enable network operators to quantify savings which can be achieved through reinforcement deferral and avoidance while facilitating the transition to low carbon transport.	Through use of the Strategic Forecasting System, the project has quantified the potential impact of smart charging on network investment. UK Power Networks' assumptions on the impact of commercial EVs were updated based on the trial findings. Further details can be found in Deliverable D7.

5.2 Objectives

The project's objectives were summarised in three key questions in the project's full submission, detailed in Table 7. The project's final deliverable, D7 was structured to answer these questions based on the findings of the project's trials.

Table 7 – Objectives of Optimise Prime

Question	Description – from initial full submission	Evidence Location
1. How do we quantify and minimise the network impact of commercial EVs?	We will gain a comprehensive and quantified understanding of the demand that commercial EVs will place on the network, and the variation between fleet and vehicle types. We will achieve this through large-scale field trials where we will capture and analyse significant volumes of real data leading to the creation and validation of practical models that can be used to better exploit existing network capacity, optimise investment and enable the electrification of fleets as quickly and cheaply as possible.	Section 2.1 of Deliverable D7 answers this question, presenting findings related to load profile analysis, future demand forecasts and the results from the trialling of flexibility services, profiled connections and smart charging.
2. What is the value proposition for smart solutions for EV fleets and PHV operators?	We will gain an understanding of the opportunities that exist to reduce the load on the network through the better use of data, planning tools and smart charging. Additionally, we will consider and trial the business models that are necessary to enable these opportunities. We will achieve this by developing technical and market solutions, and then using them in field trials to gather robust evidence and assess their effectiveness.	Section 2.2 of Deliverable D7 answers this question, detailing the value proposition of each of the project methods for fleets, while also considering the wider TCO impacts of electrification. Section 2.1.2.3 of the same report provides analysis of the cost benefit to networks of the different methods considered by the project.
3. What infrastructure (network, charging and IT) is needed to enable the EV transition?	We will understand how best to optimise the utilisation of infrastructure to reduce the load on the network. This will be achieved through the collection, analysis and modelling of fleet and PHV journey data.	Section 2.3 of Deliverable D7 answers this question, summarising the infrastructure and process requirements for fleet electrification and the provision of flexibility services. Deliverables D2 and D3 provide further details of the learnings from infrastructure implementation, while the project's Fleet Electrification Guide and Operating model provides a simple guide for fleet operators based on project learnings.

5.3 Deliverables

The project committed to share seven deliverables, consisting of six reports and a collection of datasets. All deliverables were successfully published and links to the deliverables can be found in Section 13.1 of this report. Following the decision to extend the project and delay the trials by up to one year the project notified Ofgem of revised dates for publication of deliverables D2 to D7 – all deliverables were submitted on or before these revised dates.

6 Required modifications to the planned approach during the course of the project

The following modifications were made to the planned approach for Optimise Prime, either as a result of external factors impacting the project, or to improve project outcomes:

6.1 Project extension

A key challenge of the project was the dependency on the project partners adding sufficient EVs to their fleets before the trials could begin. Due to supply constraints, especially for electric vans, it took longer than originally forecast for the partners to procure suitable EVs for their fleets.

At the outset, the project was intended to last for a little over three years but was extended by a further year to allow the partners to procure their EV fleets. As a result, the trials took place one year later than originally planned and deliverables D2 to D7 were delivered up to a year later than specified in the project direction. The change was discussed with Ofgem, who were notified by letter on 20 February 2020. While a small additional cost was incurred as a result of the extension this was offset by efficiencies made elsewhere in the project.

6.2 Trial sizes and locations

The Project Direction required that the project partners endeavoured to achieve “one thousand vehicles per trial, as committed to in the Full Submission or, if this is not possible, a number of vehicles which the Funding Licensee can demonstrate will deliver statistically significant results to each of the trials”. As a result of the delays in availability of EVs, described in 6.1, above, the project commissioned Imperial College Consultants to calculate the number of vehicles that would be needed in each trial to give statistically significant results – this was found to be in the range of 2-300 EVs per trial. Royal Mail were able to meet this minimum from nine London depots. British Gas vehicles from throughout the UK were also included in the trials, rather than just the UK Power Networks and SSEN licence areas as originally proposed. The project ensured that each trial met this minimum number before the trial period began.

Subsequently, the partners’ EV fleets continued to grow and the total number of EVs in the trials significantly exceeded original expectations, exceeding 8,000 in the final months of the trial. Table 8 shows the breakdown of trial vehicles at the end of the trial.

Table 8 – EVs per trial, June 2022

	WS1 – Home	WS2 – Depot	WS3 – Mixed
EVs per trial, June 2022	1,083	342	6,713

6.3 Separating domestic load behind the meter

When Optimise Prime was conceived, it was expected that the proposed Balancing and Settlement Code modification P379 (Multiple Suppliers through Meter Splitting) would provide an industry solution. P379 was expected to enable competition for behind-the-meter energy volumes measured by the same boundary Metering System, allowing multiple suppliers to supply the same customer. Consequently, it was expected that it would enable separation of supply to a CP and the rest of the household demand, allowing separate billing as well as an application of a different tariff to the charging demand via industry systems. This would have greatly reduced the transactional costs for fleets as compared to manual workarounds required in the absence of an industry solution.

However, P379 was withdrawn on 10 March 2021, based on a Cost Benefit Analysis, which concluded that the cost of implementing such a solution into industry systems and processes outweighed the benefits.

To overcome this change, Centrica developed and implemented a proprietary solution to enable billing for commercial loads on domestic connections, which is being implemented for British Gas fleet in parallel to the Optimise Prime project. The solution uses charging session data from CPs at drivers' homes, together with details of drivers' electricity tariffs to reimburse the drivers for electricity consumed.

6.4 Implementation of depots with at over-the-air charging control

The project designed the depot solution used in WS2 with a controller located at each site which connected to the local charge points. This solution was chosen because, at the time of submission, it was not known whether the existing CP back-office systems would have the capability to control the CPs in order to deliver flexibility services and profiled connection. As the project progressed, the opportunity to trial such a solution arose. One of the two back-office systems in use at Royal Mail was integrated with the iHost system, allowing CPs to be controlled via the CP back office. The integration was largely successful and allowed the project to add additional depots to the trial while giving the opportunity to compare the benefits of wired and wireless technologies.

7 Significant variance in expected costs

The budget for the project was based on the financial information provided at bid submission in the "Full submission financial spreadsheet". It was used to inform the budget and create the position of all costs as described in the budget section of the Funding Direction. The table below presents the view of the actual spend against bid budgeted spend to the end of the project (February 2023). Commentary is provided to supplement the budget overview table and explain any variances of +/- 5%.

7.1 Budget overview

Table 9 provides a summary of project expenditure compared with the budget given in the Project Direction.

Table 9 – Optimise Prime budget

	Budget in Project Direction	Actual expenditure	Variance	Variance (%)
Labour total	£1,492,470	£1,622,117	£129,647	9%
Equipment total	£1,200,000	£743,524	-£456,476	-38%
Contractors total	£9,355,395	£9,042,000	-£313,395	-3%
IT total	£5,248,880	£5,208,246	-£40,634	-1%
Travel and Expenses total	£18,385	£15,311	-£3,074	-17%
Other total	£1,134,680	£92,646	-£1,042,034	-92%
Grand total	**£18,449,810**	**£16,723,844**	**-£1,725,966**	**-9%**

7.2 Significant cost variances

The following commentary explains the variances between budgeted cost and actual expenditure specific cost categories.

7.2.1 Labour

The project overspent on labour costs by 9% compared to the Project Direction. This overspend is due to:

- Increased labour requirements as a result of the extended project duration (discussed in Section 6.1)
- Certain IT tasks that were planned to be outsourced were required to be undertaken by UK Power Networks employees.

7.2.2 Equipment

The project underspent on equipment by 38% compared to the Project Direction. This underspend is due to:

- Fewer depots being involved in WS2 than had been budgeted for, due to Royal Mail re-planning their EV rollout (discussed in Section 6.2)
- The project not needing to fund the installation of telematics devices in vehicles, which was budgeted for in the initial plan. This was not necessary as it was possible to interface with existing systems operated by the project partners.

7.2.3 Travel and Expenses

The project underspent on travel and expenses by 17% compared to the Project Direction. This underspend is due to the reduced ability/need to travel as a result of the COVID-19 pandemic. Videoconferencing, webinars and other collaboration tools were used in place of travel at a reduced cost.

7.2.4 Other

The project underspent on this category by 92% compared to the Project Direction. This underspend is due to:

- Flexibility payments that needed to be made were significantly lower than originally budgeted. This is because fewer vehicles than originally planned took part in the WS2 flexibility trial, fewer flexibility events were run than originally planned due to the delayed start of trials and the need to gather data at times when flexibility services were not running, for comparison purposes. A maximum rate was also applied to flexibility bids to ensure the process delivered value for money.
- Fewer in-person knowledge exchange events were organised by the project than originally planned, as a result of the COVID-19 pandemic. Online webinars were used instead, resulting in lower costs.

7.3 Overall budget performance

Overall, the project has delivered all of the key objectives and outputs whilst underspending by 9%. This underspend can mainly be attributed to reduced equipment and flexibility payment costs. The underspend has been achieved despite the significant cost pressures created by the need to extend the project by approximately one year. Project partners identified the potential need for project extension at an early stage and put in place appropriate contingencies such as delaying development tasks and re-planning the execution of the trials to be less resource intensive.

8 Updated business case and lessons learnt for the Methods

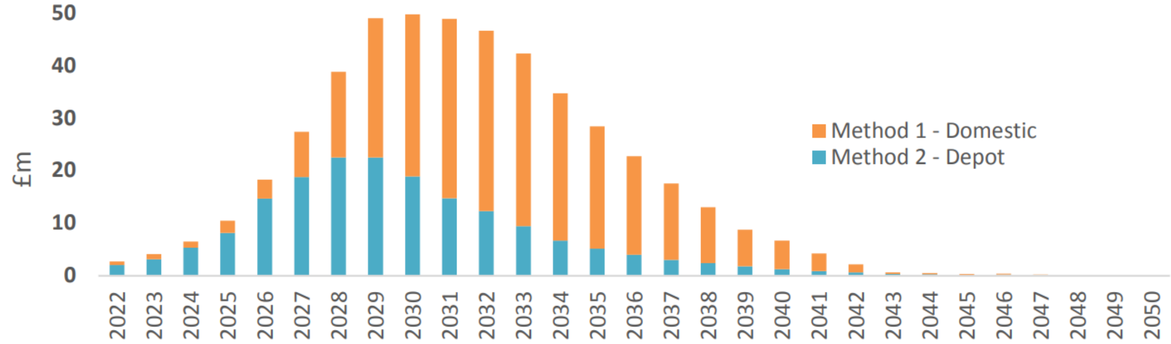
8.1 Update to the business case

8.1.1 The original business case

Network benefits

The original Optimise Prime business case predicted that Optimise Prime would save GB DNOs and electricity customers £207m by releasing over 1,900 MVA of capacity on the distribution network by 2030 if the methods were rolled out nationwide. It was expected that the project would deliver this by providing better forecasting, resulting in more accurate investment plans, as well as the project methods allowing network upgrades to be avoided or deferred. The project breakeven was expected to come by 2025/6. Figure 17, taken from the project proposal, illustrates the forecasted benefit of the project methods by year. Financial benefits were expected to be greater in Method 1, where more costs are socialised.

Figure 17 – Forecast financial impact of the project methods

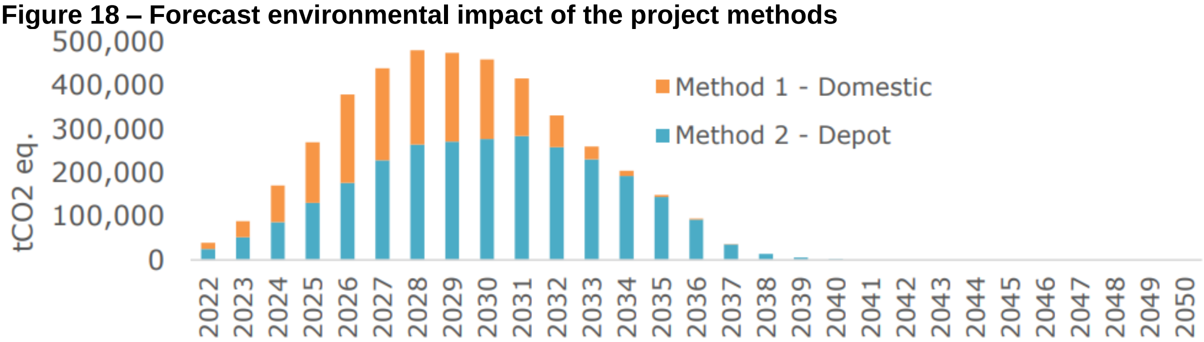


Alongside the financial saving, 1,928MVA of capacity would be released by 2030.

Environmental benefits

It was forecasted that the project would help GB achieve its carbon emission and air quality targets by delivering over 2.7m tCO_2e of carbon savings by 2030. This was to be achieved by enabling fleets to transition to EVs earlier than they would otherwise have been able to, as the project methods reduced electrification costs and timescales. Figure 18, taken from the project proposal, illustrates the forecasted benefit of the project methods by year. Financial benefits were expected to be greater in Method 2, where connection costs were more likely to be a barrier to rapid electrification.

Figure 18 – Forecast environmental impact of the project methods



Full details of the business case can be found in Section 3 and Appendix 10.3 of the Optimise Prime Full Submission.

8.1.2 Revisiting assumptions and identified benefits

8.1.2.1 Revised project cost-benefit analysis

Following the completion of the project, Optimise Prime has revisited the assumptions made in the original project business case and recalculated potential savings based on the results from trialling the project methods.

The original forecasts in the full submission were based on a number of high-level assumptions around the number of light commercial vehicles (LCVs) connected to the network, the capacity available on the network and how these two factors coincided. Estimates of the cost of reinforcement were based on analysis of a small number of sites and then scaled up to network and GB level. Since that time, UK Power Networks has developed its Strategic Forecasting System (SFS) and Distribution Future Energy Scenarios (DFES). The SFS has allowed the project to carry out much more precise analysis of network impacts in this revised analysis, based on the number of vehicles and other low carbon technologies predicted to be connected to each substation on the network and the available capacity.

In order to predict the impact of each of the project methods, average demand curves were created for EV charging in a base case scenario and using smart charging, flexibility provision and profiled connections. These were used to create scenarios in the UK Power Networks SFS, where the results from the WS1 and WS2 trials were applied to a share of the vans modelled within the SFS. By running the SFS scenarios it was possible to calculate the difference in investment in network upgrades that would be required as a result of implementing the different methods.

The outcome of this analysis is that:

In **Method 1** – Flexibility services to DNOs from commercial EVs on domestic connections – the following benefits are expected across GB:

- Financial benefit to network customers of £11m by 2030 and £102m by 2040,
- Capacity saving of 147 MVA by 2030 and 1,488 MVA by 2040,
- Carbon savings benefit of 1.2 million tCO_2e by 2030 and 1.3 million tCO_2e by 2040.

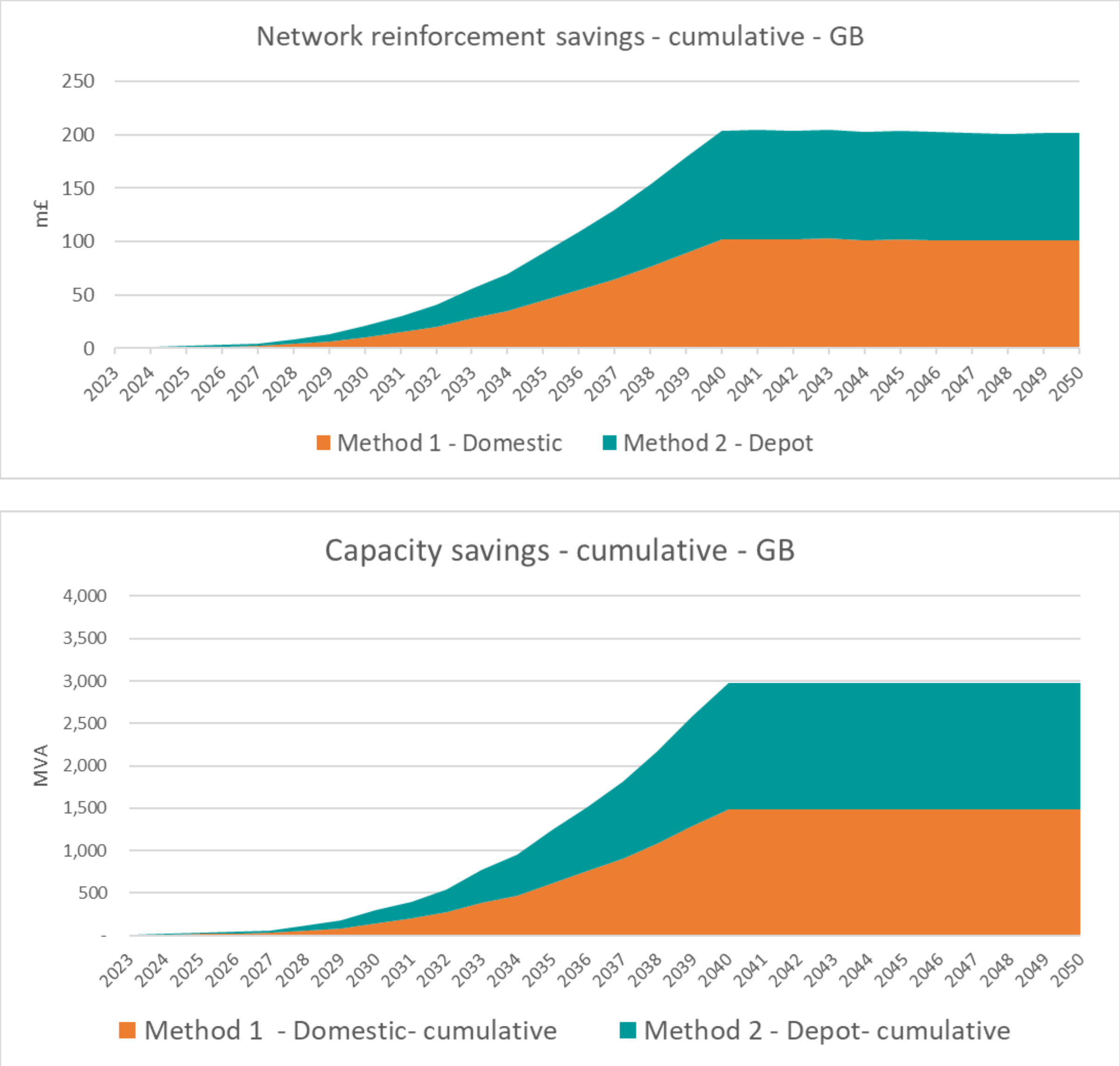
In **Method 2** – Planning tools for depot energy modelling, optimisation with profiled network connections – the following benefits are expected across GB:

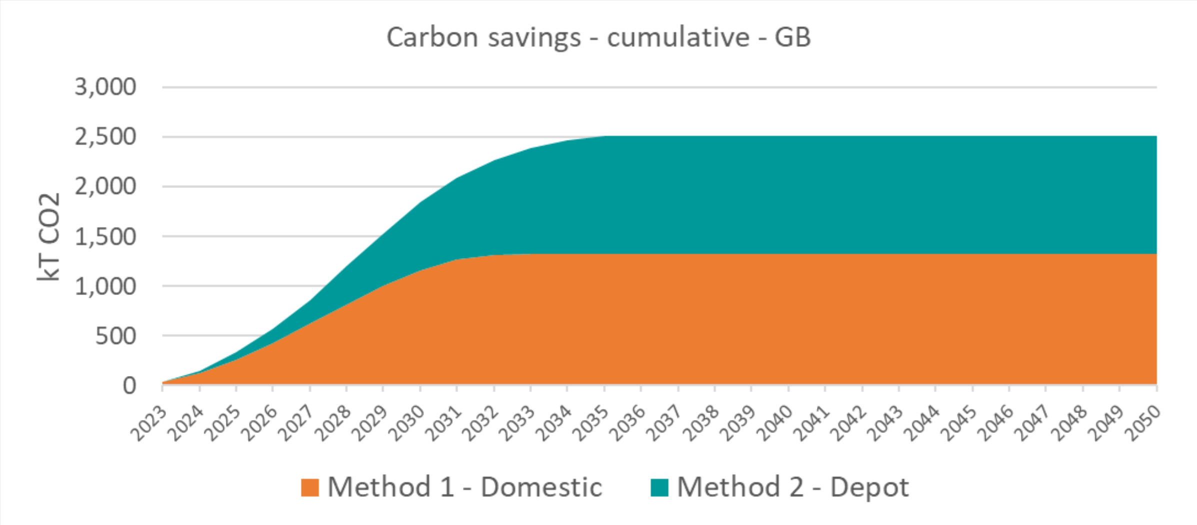
- Financial benefit to network customers of £11m by 2030 and £102m by 2040,
- Capacity saving of 147 MVA by 2030 and 1,488 MVA by 2040,
- Carbon savings benefit of 0.7 million tCO_2e by 2030 and 1.2 million tCO_2e by 2040.

Network benefits from the load flow modelling results have been split equally between Methods 1 and 2. In order to be more specific on benefits coming from purely from Method 1 or 2, accurate data on the ratio of LCVs parked at employees' homes versus those parked at company depots would be required. The project investigated multiple sources including datasets from the Department for Transport, Society of Motor Manufacturers and Traders, and insurance providers, none of which provided sufficiently accurate data to inform this exercise. One of the main complexities comes from the fact that vehicles are not necessarily registered where they operate.

Together, the methods are now expected to result in a **saving to customers of £204m,** a **capacity saving of 2,975MVA** and a **reduction in CO_2 emissions of 2.5 million tCO_2e** by 2040 across GB, as shown in Figure 19. This compares with £477m, 3,200MVA and 4.2m tCO_2e in the initial business case. While capacity savings are nearly the same as initially forecasted, financial benefits are only half mostly due to the fact that no reinforcement was found to be needed at the primary level of the network in the revised base case as a result of commercial fleet electrification at depots. This compares with estimated primary level savings of about £115m by 2030 and £369m by 2040 in the initial business case. Section 8.1.2.2 describes in more detail the drivers which have an impact on the business case.

Figure 19 – Illustration of cost, capacity and carbon savings in revised business case





8.1.2.2 Changes affecting the value of the project methods

There is a significant difference between the expected value stated in the original business case and the expected impact of the project methods. This is driven by a number of key factors:

- The **calculation methodology differed significantly** from that used in the initial business case. As described in Section 8.1.2.1, a much more accurate load flow-based network modelling and costing methodology, using UK Power Networks' DFES and SFS, was used in this revision, compared to the initial manual assessment of 100 substations extrapolated to UK Power Networks and GB. Assumptions made in the initial business case have also been revised, or replaced by observed impacts of the EVs and actual capacities of substations throughout UK Power Networks' area, in order to estimate the impact of the project more accurately.
- **No reinforcement was found to be needed at the primary level of the network** in the revised base case as a result of commercial fleet electrification at depots. This compares with estimated primary level savings of about £115m by 2030 and £369m by 2040 in the initial business case
- The **impact on peak network load and the overall demand from commercial EVs was found to be significantly less than was initially presumed**. Contribution to peak demand has been found to be 2% on average, compared to the 20% initially assumed. As a result, less network reinforcement work is expected to be triggered by commercial EVs in the base case, and there is a lower potential for savings from smart charging, profiled connections or flexibility services.

In addition, the project identified several additional factors which are likely to impact upon either the value of the methods, or the speed in which commercial fleets are able to electrify:

- **The quantum of flexible demand available from fleets is limited** by a number of factors and may not always meet the needs of the DNO, for example:
    - Load may be connected at times when there is little constraint on the network
    - Duration of flexibility provision may be limited by the relatively short or unpredictable charging times of some fleets
    - In some cases fleet managers may wish to limit the amount of flexibility that is offered (in either duration or magnitude) in order to reduce risk of disruption to their operations
- In order to model impacts across the whole DNO region it was necessary to create **average load curves** representing the impact of flexibility and profiled connection interventions observed in the trials. When implemented in a business-as-usual scenario,

these methods will be implemented to target specific network constraints, and as a result may have a greater impact than is predicted based on the network-wide results.

- **UK Government mandating the end of ICE light vehicle sales by 2030** and the sale of hybrid zero-emission capable vehicles by 2035. This is likely to bring forward the adoption of EVs by fleet operators. There may be greater need of products such as flexibility and profiled connections in the short-term as a result of this mandate. However, it is difficult to differentiate between the impacts of the project on accelerating EV adoption and the impact of the mandate.
- **Supply constraints and increased costs** caused by the COVID-19 pandemic, the war in Ukraine and other factors have had significant impacts on the supply chain for EVs and related infrastructure. As a result the project was extended by one year, the cost of EVs has not declined as rapidly as some analysts had predicted and the availability of commercial EVs has continued to be limited. This ongoing situation may continue to impact the ability of fleets to adopt EVs in the short term. The delay to the project by one year also impacted the timelines for the potential rollout of the methods. Cost parity of electric LCVs is likely to be later than was forecast at the time of the original submission, though the impact of this may be offset to some degree by the introduction of the EV mandates mentioned above.
- **Ofgem's Significant Code Review** on the connection charging boundary will reduce the potential cost of connection for some sites where upgrades require the reinforcement of shared network assets, reducing barriers to fleet electrification. Customers will however still need to meet the cost of sole-use asset upgrades. They may be able to reduce or avoid these costs using Method 2, while reducing time to connect, as the project has demonstrated through the analysis of Royal Mail sites.

8.1.3 Wider benefits

In addition to the benefits captured in the initial business case, which are mostly direct benefits to network customers, Optimise Prime has also shown that the project and its methods also deliver benefits to connecting customers, additional substantial indirect benefits through the provision of tools that streamline DNO processes, and societal benefits.

For example:

- The data and analysis generated by the trials will allow UK Power Networks and other DNOs to further improve their forecasting of future EV load based on real world observations. This should help ensure that investment plans meet future needs and that good value is achieved for bill payers without disrupting the adoption of EVs and other low carbon technologies
- The tools developed as part of the trial, including the Site Planning Tool, can help fleets and DNO accelerate the process of electrifying fleets and applying for new connections. Fleet managers will be encouraged to take the first steps in identifying their requirements before approaching the DNO with a connection request. They will be signposted to the benefits of smart charging as part of the process and will be encouraged to only request the capacity that they require
- The study of electric PHV journey data and prediction of charging requirements will provide PHV operators and other stakeholders such as local authorities and CP network operators with information needed to plan the scale and location of CP infrastructure in Greater London and will provide a basis for these parties to work together to ensure the necessary infrastructure is put in place
- The learnings from the project will provide fleet managers with a range of resources that will help inform and accelerate their adoption of EVs. This includes the project's Fleet Electrification Guide and Operating model (Deliverable D7 Appendix 6), total cost of ownership analysis (Deliverable D7 Appendix 4) and behavioural surveys which highlight key considerations of drivers and managers (Deliverable D7 Appendix 5)

- In addition to providing benefits to DNOs, flexibility from EVs can also help avoid the use of expensive generation to meet peaks in demand, reducing electricity costs.

The financial value of the project's environmental benefits can also be calculated, based on the calculated carbon savings and government guidelines on valuation of greenhouse gas emissions[1].

Table 10 provides an estimation of the potential value of these wider project benefits.

[1] Valuation of greenhouse gas emissions: for policy appraisal and evaluation - GOV.UK (www.gov.uk)

Table 10 – Estimated project benefits at GB scale

Benefit	2030		2040	
	Estimated value at project initiation	Estimated value at project end	Estimated value at project initiation	Estimated value at project end
Network benefits	**£207m**	**£23m**	**£486m**	**£210m**
Avoided network reinforcement	**£207m**	**£21m**	**£486m**	**£204m**
Method 1 – Home fleet smart charging – network savings	£91m	£10.6m	£306m	£102m
Method 2 – Depot based optimised charging – network savings	£116m	£10.6m	£180m	£102m
DNO labour savings	**Not included**	**£2m**	**Not included**	**£6m**
Method 2 – Connections/planning resource saving	Not included	£2m	Not included	£6m
Customer benefits	**Not included**	**£25m**	**Not included**	**£62m**
Reduced time spent to apply and connect	Not included	£0.5m	Not included	£1m
Reduced cost to connect	Not included	£24m	Not included	£61m
Society and environment benefits	**Not included**	**£468m**	**Not included**	**£670m**
Carbon savings – from faster EV uptake	Not included	£462m	Not included	£655m
Carbon savings – from reduced peak generation	Not included	£3m	Not included	£11m
Nitrogen oxides savings from faster EV uptake	Not included	£3m	Not included	£4m

8.2 Lessons learnt from the Methods

A key learning from the trial of the project methods is that provision of flexibility services and compliance with profiled connections are both achievable for commercial fleets.

The trials of different smart charging control methodologies have shown that peak EV load can be shifted away from times of maximum network constraint. However, if all assets are following the same price signals to minimise cost, it can result in an even higher load at another time. It will depend on local constraints as to whether this creates a greater problem for the distribution network. Additionally, the project has demonstrated that the load placed on the network by different commercial customers can vary significantly, as can the ability to shift this load reliably. It is therefore useful that DNOs have a toolbox of different incentives for different customer types. Variations of the methods, such as offering a shorter-term profiled connection as a type of flexibility product, could also be considered – this is discussed further in Deliverable D7, section 2.1.4.3.

The difference between the impact of the different managed charging scenarios was limited. Plug-in profiles aimed at replicating the observed charging behaviour in time-of-use tariff based smart charging, flexibility services and profiled connections were analysed using the SFS tool. Overall, all managed charging methods resulted in an improvement over the unmanaged scenario; however, the magnitude of the difference between the managed charging methods was much smaller.

Looking at the distribution networks in 2050, flexibility and profiled connections resulted in less benefit to the overall network as a whole than time of use smart charging. This was in part due to the relatively limited behavioural changes achieved in the trials, where events were limited in either duration or magnitude by limitations put in place to protect fleet operations.

In general, smart charging based on time-of-use tariffs led to the lowest reinforcement costs and volumes, lowest total reinforcement costs, fewest distribution network asset upgrades and lowest demand of fleet vans and PHVs at the time of a specific substation's peak. Extra high smart charging (70% of vehicles participating in smart charging by 2030) resulted in the greatest impact, followed by 'high' smart charging (35% of vehicles participating by 2030). However, at one of the four substations studied in more detail, the flexibility scenario resulted in the lowest contribution to peak demand.

In normal operations, a flexibility request or profile would be created to address specific local constraints. Creating a generalised profile from the flexibility and smart charging trials (which were generally designed to maximise response of the assets in the trial) and applying it across the whole region may have resulted in less of an impact than if bespoke flexible profiles could have been created for local constraints. The way in which the results differ across locations highlights how having a range of different smart-charging based solutions which can be deployed by the DNO in the most appropriate circumstances is advantageous.

Full details of the analysis of the network benefits of the methods can be found in Section 2.1.2.3 of Deliverable D7.

9 Lessons learnt for future innovation projects

Optimise Prime was a complex project involving a partnership of eight companies and led by a non-network licensee, Hitachi. In addition to the findings directly derived from the trials, lessons on the following topics that may be useful for network operators planning future innovation projects are presented:

Risk of reliance on the market in rapidly developing industries
When implementing projects dealing with fast developing technologies, such as the growth of EVs, there is heightened risk of external changes and factors impacting on project delivery. For example, as detailed in Section 6, the ability of project partners to buy EVs was critical for the trials to proceed. While partners committed to reasonably endeavour to provide the vehicles, they were not in a position to do so to the original project timescales due to external factors. Optimise Prime identified this risk at an early stage and as a result was able to extend the project timescales and manage the costs of doing so through careful management of the project budget, highlighting the importance of comprehensive risk management.

Reliance on third parties to deliver solutions
The solutions implemented as part of the project required a large number of interfaces between different information systems. Some of these were directly contracted to the project and others indirect suppliers to project partners over which the project had no control. On several occasions, changes were made to systems with little or no notice to the project team. Over a project the length of Optimise Prime, it should be expected that systems change or are replaced – it is important to plan to have the resources available to respond to such changes promptly.

Measuring project outcomes in a complex environment
The potential benefits from a project such as Optimise Prime are varied and are likely to accrue to a range of stakeholders over a significant period of time. As a result, measuring future value at a network or GB scale of interventions is particularly difficult. Methods like flexibility and profiled connections need to be designed to overcome local constraints, with the timing of events varying based on load. When events are modelled across large areas, for which they were not designed, they are likely to appear less beneficial than less targeted products such as time-of-use tariff based smart charging. It is therefore important to consider the full range of potential benefits and the impact on non-network parties to judge the benefits of project methods.

Non-licensee led project with multiple project partners
Hitachi ran the project on behalf of the lead DNO group, UK Power Networks, who provided oversight. A great deal of benefit is gained from the involvement of non-DNO parties, however, a close partnership between the sponsoring DNO and the project lead is essential to ensure the needs and constraints of GB DNOs are fully understood. In Optimise Prime this was achieved through regular meetings and reporting, complemented by additional sessions with DNO subject matter experts where required. It is especially important to ensure sufficient time is allocated to the review of deliverables and developing aspects of the project such as implementation into DNO business as usual processes, where external parties have more limited expertise.

Project partners sharing large amounts of potentially sensitive data
The project has shown how an ambitious, data driven project can create significant benefits for the fleet and electricity sectors. However, as a result of the nature of the data being handled, particular care had to be taken in the drafting of data sharing agreements and in putting in place the necessary control systems and processes. A significant amount of time may be required to put such measures in place. Care must also be taken in the creation and publication of project deliverables, to ensure that learnings are communicated effectively without compromising confidentiality.

When dealing with live operational sites of customers, a safe test environment is especially important
Optimise Prime set up a test site at Novuna's offices in order to replicate the infrastructure installed at Royal Mail depots without impacting live operations. A range of issues with charge

point control and integration were identified through testing (these are detailed further in Deliverable D7 Appendix 9) and could be solved before rollout to depots.

10 Project replication

Optimise Prime created a wide range of data and learnings of benefit to GB network operators and the wider energy and fleet management industries.

10.1 Project data

As part of Deliverable D6 the project has shared an extensive dataset from the trials, including charging and journey data from hundreds of commercial EVs. The data will remain accessible on UK Power Networks' Open Data Portal:

https://ukpowernetworks.opendatasoft.com/explore/dataset/optimise-prime/information/.

UK Power Networks is utilising the trials data in its ongoing business planning processes. Data from use of battery electric vans and PHVs, including charging times and volumes, is being used to improve Distribution Future Energy Scenarios, and to improve forecasting in the Strategic Forecasting System, where data of this granularity was not previously available. The Distribution Future Energy Scenarios and Strategic Forecasting System results help UK Power Networks make informed network reinforcement decisions.

While some of the data generated is specific to the UK Power Networks and SSEN regions, the majority of the data collected is applicable for to DNOs nationwide as they consider the future impact of EVs on their networks.

10.2 Optimise Prime infrastructure and technology

The Optimise Prime project partners developed and implemented a range of technology solutions to support the Optimise Prime trials. Parts of the trials' infrastructure was developed to enable analysis of data for the purposes of the trials, while other elements will be available to allow fleets and DNOs to make use of the project methods.

The project's data platform developed by Hitachi, which existed for the purpose of the trials only, has been decommissioned. The data captured in the project was shared in the form of Deliverable D6.

Hitachi's charging management technologies used in the Optimise Prime depots are available as part of the Lumada ZeroCarbon Cloud suite of products. More information on this can be found at http://zerocarbon.hitachi.com. The Site Planning Tool, found at https://www.ukpowernetworks.co.uk/optimise-prime/site-planning-tool-introduction, can be used by any site manager aiming to install multiple EV CPs, regardless of their location in GB.

Centrica's EV and energy management solutions used in the project are available from Centrica Business Solutions – for more information visit:
https://www.centricabusinesssolutions.com/energy-solutions/.

UK Power Networks made several changes to its systems and infrastructure in order to enable the project methods. This included:

- Implementing changes to its ANM system, Strata, to offer and manage new flexibility products and profiled connections
- Making changes to connection planning systems to offer profiled connections with a 48 half-hour period granularity

- Integrating monitoring with the ANM system to provide alerts of profiled connection breaches
- Hosting the Site Planning Tool
- Improving accuracy of Distribution Future Energy Scenarios and of the Strategic Forecasting System.

GB DNOs interested in making use of these developments can contact UK Power Networks using the details in Section 16 of this report.

10.3 Intellectual Property Rights (IPR)

The project recognises the importance of knowledge sharing as a vehicle for widespread adoption of its learnings to facilitate replication. The project conformed to NIC IPR requirements, and this was formalised via the collaboration agreement between all partners that reflects acceptance of these arrangements in full. The newly generated intellectual property from the project is documented in Section 9 of each project progress report (see Table 16) and summarised in Table 18.

Sections 12 and 13 also contain links to documents that facilitate project replication.

11 Planned implementation

UK Power Networks intend to utilise learnings from the projects, and key elements of the methods trialled in order to improve service to connecting customers with EV fleets while minimising costs to other network customers. This section highlights the key ways in which UK Power Networks will implement the project's methods and learnings in their business as usual activities.

11.1 Method 1 – Flexibility services to DNOs from commercial EVs on domestic connections

UK Power Networks is committed to a flexibility first approach to meeting requirements for network reinforcement. Flexibility is used in place of network reinforcement wherever it is found to be more cost effective to network customers. This approach requires increasing amounts of flexible capacity at different points of the network in order to provide sufficient capacity. UK Power Networks is continuing to develop its use of flexibility and has recently held a consultation where it described its proposals for local flexibility services and invited comments from stakeholders. Findings from the project will be taken into account when developing future flexibility products, for example:

- Learnings from the use of the UK Power Networks ANM system to dispatch flexibility services for day ahead products automatically
- Design of flexibility products and related processes that take into account the variety of assets that may be providing flexibility and the differing predictability, allowing more EVs to take part in future bids, and offer larger amounts of demand response
- Consideration of the impact of secondary peaks in the design and dispatch strategy of flexibility products.

11.2 Method 2 – Planning tools for depot energy modelling, optimisation with profiled network connections

Profiled connections build on an existing timed connection product offered by UK Power Networks. Based on the learnings generated through the trials of Method 2, UK Power Networks is taking the following actions:

- The Site Planning Tool has been launched by UK Power Networks for use by customers planning their EV transition. While the tool was originally conceived as part of the Profiled Connections product it has proved useful in helping a range of customers aiming to install multiple CPs consider their infrastructure and power requirements before making a formal connection request. The tool can be accessed at: https://www.ukpowernetworks.co.uk/optimise-prime/site-planning-tool-introduction
- Systems have been updated, including the network planning tool and the monitoring capabilities of the ANM systems to allow the offer and monitoring of profiled connections
- Work is ongoing to finalise the ANM failsafe functionality and implement the contractual and process changes necessary to offer profiled connections to customers as a standardised product.

11.3 Non-method findings

In addition to the use of the project methods and the Site Planning Tool, UK Power Networks is utilising the trials data in its ongoing business planning processes. Data from use of battery electric vans and PHVs, including charging times and volumes, is being used to improve Distribution Future Energy Scenarios, and to improve forecasting in the Strategic Forecasting System, where data of this granularity was not previously available. The Distribution Future Energy Scenarios and Strategic Forecasting System results help UK Power Networks make informed network reinforcement decisions.

12 Learning dissemination

Optimise Prime has generated a wealth of knowledge and benefits for the wider DNO community as well as the fleet and energy industries. In order for the full value of the project to be realised, the project has taken great care to share and make available all the learnings of the project by organising, and taking part in, a wide range of dissemination activities, summarised in this section.

The project partners intend to continue dissemination of key project learnings to the wider energy industry and policy makers. Specifically, the UK Power Networks Innovation team will continue to disseminate the project learning and explore potential elements which could be implemented into the business. UK Power Networks will be engaging with other DNOs to ensure key learnings can be replicated and potentially made available to customers across Britain.

12.1 Learning dissemination mechanisms

Lessons from the project have been shared via the deliverable reports and project progress reports which are available on the project website, as well as through presentations and briefings, social media and media coverage. This section details the key events that took place throughout the project.

12.1.1 Specific dissemination activities

For each mechanism details of instances and occurrences can be found in Table 11.

Table 11 – Summary of dissemination activities

Mechanism	Number of instances/occurrences
Project website	Over 22,000 visits from 17,000 unique visitors
Progress reports	Seven
Deliverable reports	Seven
Dissemination webinars, stakeholder briefings and events	Seven, including three webinars delivered jointly with SP Energy Networks' project Charge.

Mechanism	Number of instances/occurrences
Social media posts	600+ LinkedIn followers, over 38,000 post impressions in 2022/3 55 tweets, over 75,000 impressions throughout the project
Data shared	26 tables, 188GB
Conference and event presentations	16
Project videos	11 videos introducing the project, its goals and outcomes have been created and created by project partners – over 6.7 million views in total

12.1.2 Conference presentations and papers

Throughout the project Optimise Prime team members have taken part in many conferences and events in order to share the project's learnings. Table 12 lists key events throughout the project. A full listing of conferences and events can be found in the regular Project Progress Reports.

Figure 20 – Ian Cameron, UK Power Networks' Director of Customer Services and Innovation introduces Optimise Prime's Methods at a COP26 session

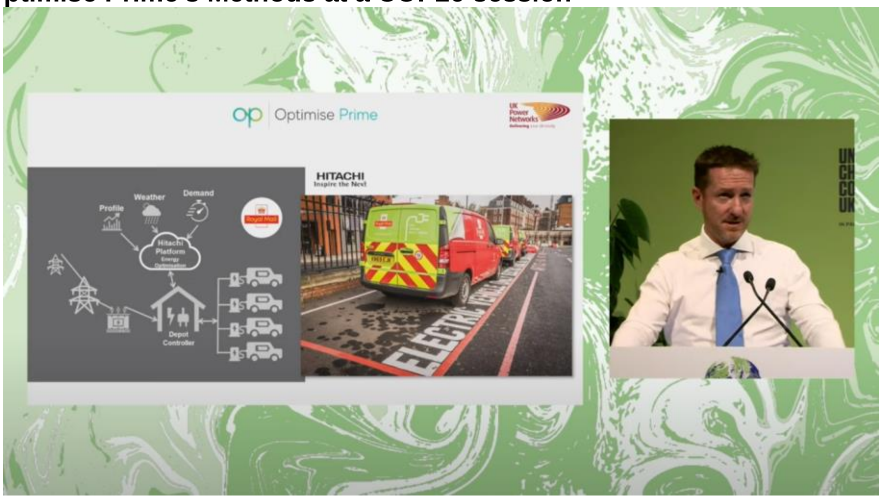


Table 12 – Project contributions to industry conferences

Conference	Contribution
CIRED 2019 (June 2019)	UK Power Networks introduced Optimise Prime as a case study in a round table discussing Distributed Energy Resources
Solar and Storage Live (September 2019)	UK Power Networks, Hitachi & Centrica joined plenary session
IoT Solutions World Congress (October 2019)	Presentation by Hitachi introducing the project
Low Carbon Networks & Innovation Conference 2019 (31 October 2019)	Presentation introducing project to GB DNOs
BVRLA Industry Outlook Conference (December 2019)	Presentation by UK Power Networks
Greater London Freight Council (16 January 2020)	Presentation by UK Power Networks
Big Data LDN 2020 (24 September 2020)	Presentation exploring Optimise Prime's use of data to drive environmental improvements
The Virtual Fleet & Mobility Live 2020 (18 November 2020)	Video presentation summarising activities in the first year of the project
Cenex-LCV 2020 (19 November 2020)	Presentation providing update on the progress of the project and introducing some early learnings

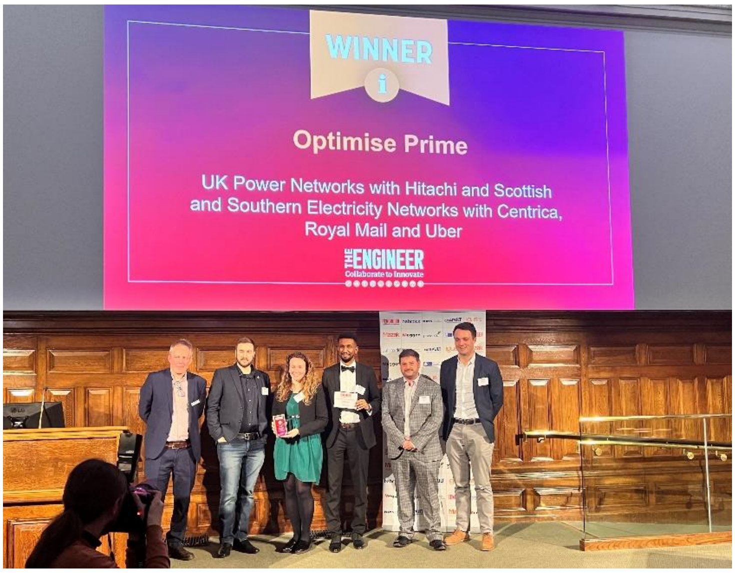
Conference	Contribution
Energy Networks Innovation Conference 2020 (8-9 December 2020)	Information on the project was made available as part of the UK Power Networks virtual stand
everythingEV Conference (20 April 2021	UK Power Networks, Royal Mail and Uber and presented Optimise Prime as a case study
Cenex-LCV 2021 (22 September 2021)	Jointly hosted workshop with SP Energy Networks Charge Project discussing how DNOs can support mass EV uptake
Energy Networks Innovation Conference 2021 (12-15 October 2021)	A Q&A session on project progress and outcomes was held
COP26 (November 2021) (Figure 20)	Presentation and panel participant at 'Technology and data are key to save the environment' event hosted by Hitachi
CIRED Porto Workshop 2022, E-mobility and power distribution systems (2 June 2022)	Paper on interim findings presented by UK Power Networks at the conference
ENERGYx2022 South Conference (15 June 2022)	Presentation by UK Power Networks on project interim findings
UK Power Networks/Scottish and Southern Electricity Networks Better Networks Forum (6 July 2022)	Exhibition stand promoting the project to attendees
Energy Innovation Summit 2022 (28-29 September 2023)	Presentation by UK Power Networks on project progress and outcomes

12.1.3 Industry recognition and awards

The project has been nominated for a number of awards.

Industry awards:
The Engineer Collaborate to Innovate Awards 2022 – Category Winner, Information Data & Connectivity (Figure 21).

Figure 21 – The Optimise Prime team collect the Information, Data and Connectivity award at The Engineer's Collaborate to Innovate Awards



Industry award nominations:
Utility Week Awards 2022 – Innovation Award (Shortlisted)
Edie Awards 2023 – Partnership and Collaboration of the Year (Finalist)

Internal partner awards:
Hitachi Transformation Awards 2019, winner Environmental Sustainability
Hitachi Inspiration of the Year Global Award 2021, European Grand Prix winner

12.1.4 Learning and dissemination webinars and workshops

The project has organised and participated in a number of webinars and workshops. Table 13 lists key events where the project presented findings or project methods. A more detailed listing can be found in the regular Project Progress Reports.

Table 13 – Project learning dissemination webinars and workshops

Event	Contribution
UK Power Networks' Net Zero Networks Forum (March 2020)	UK Power Networks and Hitachi representatives presented an update on progress in delivering Optimise Prime
Changing Lanes Webinar (23 April 2020)	Hosted in collaboration with SP Energy Networks' Charge project, Changing Lanes shared early insights from the Optimise Prime trials.
Cornwall Insight EV Charging and Infrastructure forum (January 2021)	Project update presented by UK Power Networks
Green fleets: progress in switching to EVs – TechUK Webinar (1 July 2021)	The discussion covered issues relating to the electrification of commercial fleets and gave an update on the progress made so far in Optimise Prime.
Electrifying your EV fleet – SSEN and SP Energy Networks stakeholder event (23 March 2022)	The Site Planning Tool was introduced to stakeholders
UK Power Networks Competition in Connections customer forum (29 March 2022)	The Site Planning Tool was introduced to stakeholders
Innovation Gateway EVzero Event (8 April 2022)	The Site Planning Tool was introduced to stakeholders
Cornwall Insight EV Charging and Infrastructure forum (19 May 2022)	Presentation by UK Power Networks on project findings
Getting connected webinar: the future of EV charging infrastructure (9 November 2022)	This webinar, hosted together with colleagues from SP Energy Networks' Charge project gave an overview of the findings of these two complementary projects, focused on solutions to help accelerate electrification through solutions for fleet and public charging.
Enabling the EV Revolution webinar: Driving the network (23 November 2023)	In this webinar UK Power Networks and SP Energy Networks jointly presented the solutions pioneered as part of the Optimise Prime and Charge projects to enable to EV CP connections. Topics covered include Flexible connections, Flexibility services, EV charging demand modelling, Network capacity data and pricing availability.

The final webinar, presented together with SP Energy Networks' Charge project on 23 November 2022 was aimed at sharing project findings with network licensees and industry stakeholders and invited questions about the project. This webinar was attended by 110 people, including representatives of SSEN, Northern Ireland Electricity Networks, Northern Gas Networks, National Grid ESO, the Department for Business, Energy and Industrial Strategy, the Energy Networks Association, Energy Systems Catapult, Transport for London, seven local authorities and several universities and fleet operators.

12.1.5 Project close down event – January 2023

UK Power Networks hosted a project close down event on 18 January 2023 at the Science Gallery, London.

The event, titled ‘Optimise Prime: Helping fleets go electric’, was attended by 94 delegates from a range of sectors including other DNOs, National Grid ESO, Local Authorities, TfL, industry associations and fleet operators. 77% of the fleets in attendance already operate EV. Project team members gave an introduction to the project’s key findings, as well as the tools and methods created by Optimise Prime in order to help fleets electrify more quickly. A panel session was held with fleet managers from the project partners, allowing the audience to ask questions about their experience of electrification and the Optimise Prime methods.

In post-event feedback 100% of respondents said the event helped them with fleet electrification, with ‘hearing from the fleets themselves and understanding real world experience’, ‘presentation of clear products that fleets can use’ and ‘opportunities to engage’ ranked as the three most useful aspects of the day.

Figure 22 – Close down event and panel session

12.2 Leveraging existing learning

Optimise Prime built on learnings from a number of past projects in order to plan and carry out the trials. Significant examples of this are listed below;

- Throughout the project, Optimise Prime has collaborated with Charge, a SP Energy Networks project in order to create joint opportunities for stakeholders to learn about these two complementary projects. This also allowed the projects to ensure that there was no overlap between the projects
- In order to develop the approach to flexibility, the project has considered a number of innovation projects, such as National Grid Electricity Distribution’s Intraflex and SP Energy Networks’ Project Fusion, in addition to UK Power Networks’ Flexibility Roadmap, to ensure the flexibility learnings of Optimise Prime are compatible with flexibility services being implemented in GB
- The project has built upon the Distribution Future Energy Scenarios (DFES), developed by UK Power Networks together with Element Energy as a basis of analysis of the network impact of the Optimise Prime methods. Data from Optimise Prime, together with learnings from the White Van Plan and Recharge the Future projects will be used to further improve the DFES going forward

- The CPC solution implemented in the depot trials, selected as part of a competitive tender, built on a proven solution that has been tested in National Grid Electricity Distribution's LV Connect and Manage and Industrial & Commercial Storage NIA projects
- UK Power Networks have built upon their timed connections planning solution, developed in the Timed Connections Software Development NIA project to develop the tools necessary to plan profiled connections
- Use of modelled load data from the Envision project was considered as a potential proxy for site monitoring in when setting profiled connections.

12.3 Peer review of project findings

Optimise Prime has involved the partnership of two Network Licensee companies, UK Power Networks and Scottish and Southern Electricity Networks. In addition, the project has worked closely throughout with SP Energy Networks, with whom the project has partnered with to deliver learning and dissemination events.

SP Energy Networks was asked to review the project's close down report and noted that the project deliverables, progress reports and close down report are clearly written, and that their contents are understandable, containing sufficient detail to enable another DNOs to make use of the learning generated to implement their own network solution as part of Business as Usual. This is illustrated in SP Energy Networks' letter in Appendix 3.

13 Key project learning documents

13.1 Deliverable reports

Seven deliverables were issued throughout the project, in line with the requirements of the Project Direction. All reports were published on or before the deadline date communicated with Ofgem. Table 14 outlines the contents of each deliverable and provides a link to each document on the project website.

Table 14 – Deliverable Reports

No.	Document title & link	Deadline	Publication date	Description of contents
D1	High Level Design and Specification of the Three Trials	30 August 2019	29 August 2019	Report outlining the requirements, use cases, scenarios, technologies and locations for WS 1 (Home Charging), WS 2 (Depot Charging) and WS 3 (Mixed Charging).
D2	Solution Build Report – Lessons Learned	26 February 2021	27 November 2020	Report setting out the lessons learned from the infrastructure and technology build for the trials. The report also includes a description of the methodology to be used for trials.
D3	Learning from Installation, Commissioning and Testing	27 August 2021	23 August 2021	Report setting out the key learning points from the installation, commissioning and testing processes/activities.
D4	Early Learning Report on the Trials	18 February 2022	21 January 2022	Report setting out how each trial is performing, data gathered, insights gained, changes required.

No.	Document title & link	Deadline	Publication date	Description of contents
D5	Interim Report on Business Models	13 May 2022	10 June 2022	Interim report outlining the preliminary economic and behavioural findings, high level options for commercial solutions/business models, profiled connections and commercial EV load separation at domestic properties.
D6	Data Sets	18 November 2022	1 November 2022	Data released includes telematics and charging data from homes and depots, data from the trials and aggregated demand from private hire vehicles. The data set can be found on the UK Power Networks Open Data Portal.
D7	Final Learning Report	10 February 2023	7 February 2023	A report summarising the work undertaken, the insights gained from the trials giving recommendations on approaches for separating commercial EV load at residential level, explaining models for use of commercial EV flexibility by DNOs including insights into flexibility contracts for DNOs, recommendations on business models for fleet operators, the methodologies and reference design for the site planning tool and insights on applicability of Methods to EV stakeholders.

The final learning report was accompanied by a series of appendices which provide further details of several aspects of the project's outcomes.

Table 15 – Appendices to the Final Learning Report

Appendix	Title & link	Description of contents
1	Use of commercial flexibility by Distribution Network Operators	Description of the results of the trials of Flexibility services (Method 1) and profiled connections (Method 2)
2	Findings from the Optimise Prime Trials	Analysis of the home, depot and mixed charging trials. Covers operational fleet analysis, load profile analysis and future forecasts.
3	Third party analysis based on project data	Summary of findings from analysis of project data completed by third party consultancy CK Delta
4	Fleet Total Cost of Ownership Analysis	Outcomes of electrification TCO analysis carried out by the project based on the three fleet archetypes
5	Behavioural findings	Results of behavioural surveys carried out with drivers and managers of the project partners and other electrifying fleets
6	Fleet electrification guide and operating model	A guide for fleets looking to electrify based on the experience the project partners gained in Optimise Prime. This report is also published as a stand-alone document on the UK Power Networks website.
7	Site planning tool methodology and reference design	Description of the architecture and processes of the project's Site Planning Tool

Appendix	Title & link	Description of contents
8	Results of the trial experiments	Explanation of the results from carrying out the trial experiments
9	Practical learnings from trial implementation	An overview of the key learnings from implementing and operating the technical solutions, building on the initial learnings presented in Deliverables D2 and D3.

13.2 Project progress reports

During the project, progress reports were regularly submitted to Ofgem and published on the project website. These reports tracked progress against plan for the individual workstreams and the project as a whole, discussed deliverables, learning and dissemination activities, and listed identified risks and mitigation measures. Table 16 lists these reports and their location on the UK Power Networks innovation website.

Table 16 – Project Progress Reports

Report title and link	Publication date	Period covered
Annual Project Progress Report 2019	19 December 2019	December 2018 – December 2019
Project Progress Report June 2020	16 June 2020	December 2019 – June 2020
Project Progress Report December 2020	11 December 2020	June 2020 – December 2020
Project Progress Report June 2021	17 June 2021	December 2020 – June 2021
Project Progress Report December 2021	8 December 2021	June 2021 – December 2021
Project Progress Report June 2022	17 June 2022	December 2021 – June 2022
Project Progress Report December 2022	20 December 2022	June 2022 – December 2022
Project Progress Report March 2023	20 March 2023	December 2022 – February 2023

In addition to the linked document, each PPR was accompanied by a confidential appendix providing details of vehicle acquisition progress and project finances, which was shared directly with Ofgem.

13.3 Miscellaneous additional reports

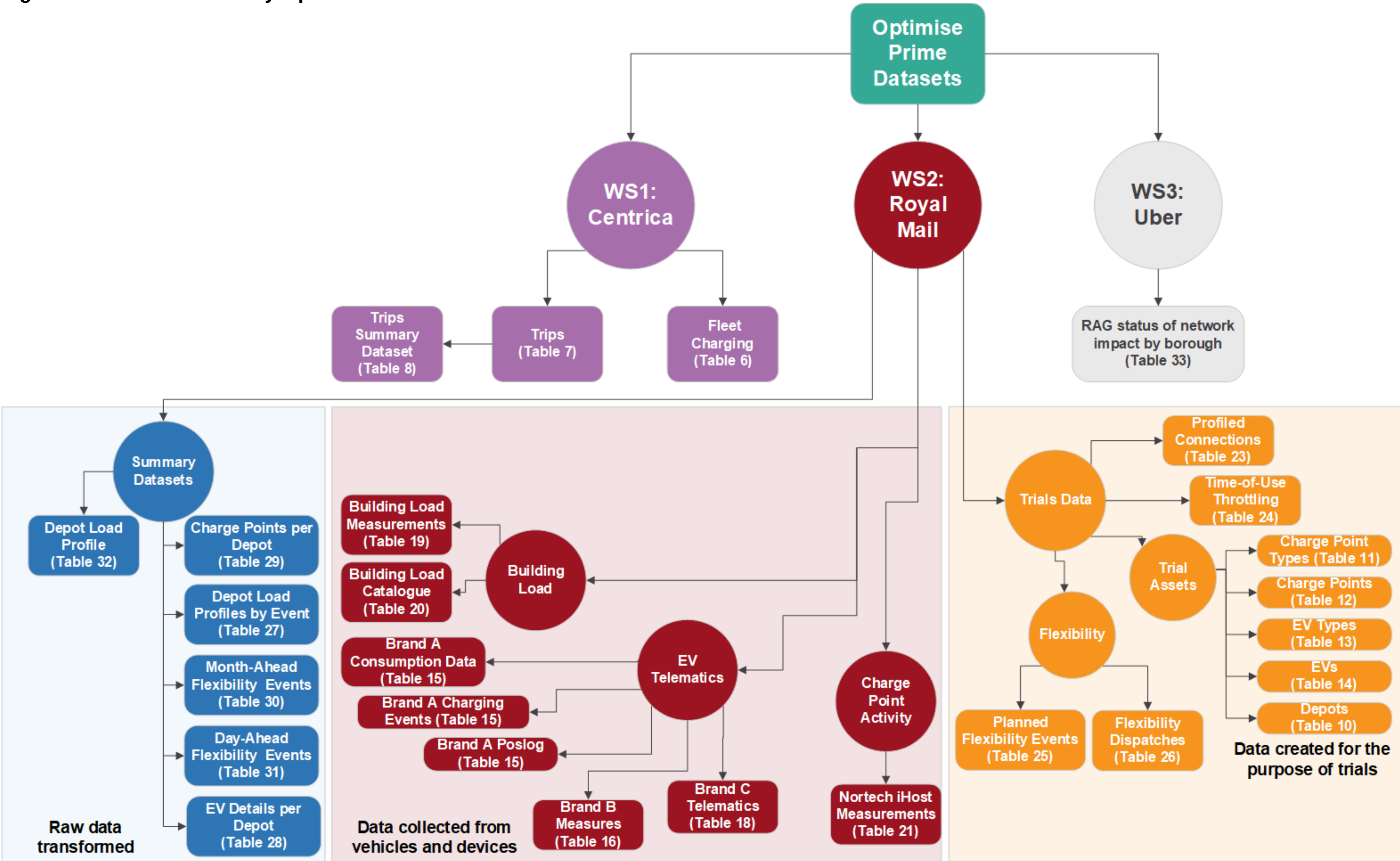
Various other documents were published during the project that contain key learnings and insights, notably conference papers and presentations (please see Section 12) and the fleet electrification guide. All of the project's published documents can be found on the project website at https://www.optimise-prime.com/learning

14 Data access details

It is recognised that innovation projects of this nature may produce network and consumption data, and that this data may be useful to others. This data may be shared with interested parties whenever it is practicable and legal to do so and it is in the interest of GB electricity customers. When such data is available the project will provide access to non-personal, non-confidential/non-sensitive data on request, in line with UK Power Networks' Innovation Data Access Policy, http://innovation.ukpowernetworks.co.uk/wp-content/uploads/2021/11/UK-Power-Networks-Innovation-Data-Sharing-Policy-.pdf.

As part of Deliverable D6, the project made a comprehensive dataset resulting from the trials openly available. Further summary datasets have since been released in order to make the data simpler to use and interpret. This data, summarised in Figure 23can be accessed on UK Power Networks' Open Data Portal.

Figure 23 - Data released by Optimise Prime



15 Material change information

No material changes have been encountered during the project.

16 Contact details

Details of the project and its learnings can be found on the Optimise Prime website and UK Power Networks' Innovation website.

For further details, please contact:

Florentine Roy and Muhammad Musa

innovation@ukpowernetworks.co.uk

Optimise Prime Project
UK Power Networks
237 Southwark Bridge Road
London
SE1 6NP

Appendix 1 – Project Partners

Table 17 – Project Partners

Partner	Description	Project Role
HITACHI Inspire the Next	Hitachi is a leading global technology group committed to bringing about social innovation. Two Hitachi companies were project partners: Hitachi Vantara and Hitachi Europe.	Hitachi led the project, providing overall project management, energy and fleet expertise and project IT platforms. Hitachi also developed tools for the depot trial.
UK Power Networks	Electricity DNO covering three licensed distribution networks in South East England, the East of England and London. The three networks serve over eight point four million customers.	London Power Networks was the project's funding licensee. UK Power Networks provided networks expertise and is developing new connections methodologies and flexibility products.
Scottish & Southern Electricity Networks	The electricity DNO covering the north of the Central Belt of Scotland and Central Southern England.	Supported experiments within the Central Southern England region, ensuring wider applicability of methods.
Royal Mail	Royal Mail provides postal delivery and courier services throughout the UK. It manages the largest vehicle fleet in the UK with over 48,000 vehicles based at 1,700 delivery offices.	Royal Mail is electrifying depots and operates EVs. Project tools were tested in the depots and data from the vehicles was captured.
Uber	Uber is the fastest growing PHV operator in the UK. Over 70,000 partner-drivers use the app in the UK, with the majority in and around London.	Uber provided journey details from EV PHVs operating in London for the mixed trial.
centrica	Centrica is a UK based international energy and services company that supplies electricity, gas and related services to businesses and consumers.	The British Gas commercial vehicle fleet participated in the trial. Centrica also provided charging and aggregation solutions for the home trial.
Novuna Vehicle Solutions	Novuna Vehicle Solutions, formerly Hitachi Capital Vehicle Solutions, is one of the UK's 10 largest leasing companies, with a fleet of over 95,000 vehicles ranging from cars and vans to HGVs.	Novuna supported the project's behavioural research activities, provided insight to the fleet market and supported the testing of the project's charging solutions.

Appendix 2 – Intellectual Property Rights

Table 18 lists any relevant IP that has been generated or registered during the reporting period along with details of who owns the IPR, any royalties that have resulted.

Table 18 – Intellectual Property Rights

IP Description	Owner(s)	Type	Royalties	Year
Solution Architecture Design	Hitachi	Relevant foreground IPR	Nil	2019
Trial Design Royal Mail	Hitachi, Royal Mail, UK Power Networks	Relevant foreground IPR	Nil	2019
Trial Design Centrica	Hitachi, Centrica, UK Power Networks	Relevant foreground IPR	Nil	2019
Trial Design Uber	Hitachi, Uber, UK Power Networks	Relevant foreground IPR	Nil	2019
Deliverable D1	All project partners	Relevant foreground IPR	Nil	2019
Universal Service Platform & Analytics Solution High Level Design	Hitachi	Relevant foreground IPR	Nil	2019
Trials Operational Applications High Level Design	Hitachi	Relevant foreground IPR	Nil	2019
Prototype Depot Planning Model	Hitachi	Relevant foreground IPR	Nil	2019
Depot Planning Model High Level Design	Hitachi	Relevant foreground IPR	Nil	2019
Prototype Depot Planning Model – updated version	Hitachi, UK Power Networks	Relevant foreground IPR	Nil	2020
Deliverable D2	All project partners	Relevant foreground IPR	Nil	2020
Profiled Connection Agreements – requirements approach & definitions	Hitachi, UK Power Networks, SSEN, Royal Mail	Relevant foreground IPR	Nil	2020
Flexibility High Level Design	Hitachi, UK Power Networks, SSEN, Royal Mail	Relevant foreground IPR	Nil	2021
Optimise Prime API Specification	UK Power Networks	Relevant foreground IPR	Nil	2021
Optimise Prime Flexibility Product Design	UK Power Networks, Hitachi	Relevant foreground IPR	Nil	2021
Optimise Prime Site Planning Tool	Hitachi, UK Power Networks	Relevant foreground IPR	Nil	2021
TCO Model – High level design	Hitachi, UK Power Networks, Royal Mail	Relevant foreground IPR	Nil	2021
Optimise Prime Depot Management System	Hitachi	Relevant foreground IPR	Nil	2021
Deliverable D3	All project partners	Relevant foreground IPR	Nil	2021
Deliverable D4	All project partners	Relevant foreground IPR	Nil	2022
Deliverable D5	All project partners	Relevant foreground IPR	Nil	2022
Deliverable D6	All project partners	Relevant foreground IPR	Nil	2022
Deliverable D7	All project partners	Relevant foreground IPR	Nil	2023

Appendix 3 – DNO peer review of the close down report

Process and Technology/Future Networks | SP ENERGY NETWORKS

FOA: PETER PAPASOTIRIOU
Programme Manager
Newington House
237 Southwark Bridge Road,
London
SE1 6NP

Andrew Moon
Lead Innovation Engineer
SP Energy Networks
3 Prenton Way
Wirral
CH43 3ET

March 2023

Dear Peter,

Optimise Prime Closedown Report - DNO Peer Review

In relation to your request for SP Energy Networks to review the Close-Down Report, produced in respect of UK Power Networks Optimise Prime NIC funded project, I can confirm that SP Energy Networks have undertaken this review and consider that the objectives and deliverables, as agreed in the January 2019 Project Direction, have been satisfied by UK Power Networks.

SP Energy Networks can confirm that it considers the Close-Down Report, deliverables and progress reports to be clearly written and their contents are understandable, containing sufficient detail to enable another DNO to make use of the learning generated to implement their own network solution, as part of Business as Usual.

Please don't hesitate, should you wish to discuss anything further or have any additional requirements that you need to address in respect of the Optimise Prime project.

Yours faithfully,

Andrew Moon

Andrew Moon

Lead Innovation Engineer

SP Energy Networks

SCOTTISH POWER ENERGY NETWORKS HOLDINGS LIMITED / 320 St Vincent Street – Glasgow / G2 5AD

Table of Figures

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