NIC Project UKPNEN03 Deliverable D6

Data Sets

Guidance Document

October 2022

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
3P-DP	Third Party Data Provider
AC	Alternating Current
API	Application Programming Interface
ASC	Authorised Supply Capacity
CAN bus	Controller Area Network bus, a vehicle communication network standard
CP	Charge Point
CPO	Charge Point Operator
DNO	Distribution Network Operator
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment (an alternative name for CP used in some systems)
FSP	Full Submission Pro-forma
GB	Great Britain
GSM	Global System for Mobile communication
hm	Hectometre (100 metres)
HV	High Voltage
IT	Information Technology
JSON	JavaScript Object Notation, a data interchange format
kVA	Kilovolt-ampere
kW	Kilowatt
kWh	Kilowatt hour
LSOA	Lower Layer Super Output Area
NIC	Network Innovation Competition
OCPP	Open Charge Point Protocol
PHV	Private Hire Vehicle
RAG	Red-Amber-Green
RFID	Radio-Frequency Identification
SoC	State of Charge
TOA	Trials Operational Applications
UK	United Kingdom
UTC	Coordinated Universal Time
Wh	Watt hour
WS	Workstream

Executive summary

Optimise Prime is a third-party industry-led electric vehicle (EV) innovation and demonstration project that brings 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 (formerly Hitachi Capital Vehicle Solutions).

The project has gathered data from over 6,000 EVs driven for commercial purposes through three trials. Optimise Prime has also implemented a range of technical and commercial solutions with the aim of accelerating the transition to EVs for commercial fleet operators, while helping GB's distribution networks plan and prepare for the mass adoption of EVs.

Through cross-industry collaboration and co-creation, the project has been aiming to reduce the impact of EVs on distribution networks and ensure security of electricity supply while saving money for electricity customers, helping the UK meet its clean air and climate change objectives. The project consists 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 uses private hire vehicle (PHV) journey data to model the impact of these vehicles on the distribution network.

The trial period for WS3 began in August 2020, with WS1 and WS2 trials commencing on 1 July 2021. All trials concluded at the end of June 2022.

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, deployed 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

Optimise Prime's sixth deliverable consists of the project datasets, which are being made publicly available. The data will allow the wider electricity, fleet and PHV industries to optimise their vehicle electrification plans while DNOs, academics and interested parties will be able to utilise this anonymised data created by the project for further research, analysis and forecasting. This document complements the datasets, providing information on the content of those datasets, guidance on how to interpret each data field and instructions on how to access the data.

Over the course of the trials, the project has collected and analysed data from a wide range of sources in order to carry out a wide range of experiments. The key datasets collected and used in analysis are included in this deliverable. The project is not able to release all data collected and used by the project, as some are commercially confidential to the project partners (such as precise volumes of Uber trips or secondary substation capacities), contain potentially personally identifiable information (such as precise start and end locations of home charging journeys or Uber trips) or were purchased by the project under licence (e.g. charge point (CP) locations, weather data and off-street parking data).

The key data tables, which are explained later in this report, include:

WS1 – Return-to-Home Trials

- CP session data
- Vehicle telematics journey data

WS2 – Depot Trials

- Details of the assets and asset types at each depot
- Vehicle telematics data
- Charging data gathered from the CPs at each depot
- Building load measurement data from each depot
- Details of the profiled connections, flexibility trials and smart charging profiles trialled at each depot

WS3 – Mixed Trials

- PHV charging demand overlaid onto substation available capacity data aggregated by borough

Table 2 shows the requirements of Deliverable D6, set out in the Project Direction, and how this requirement has been met.

Table 2 – Deliverable D6 Requirements

Deliverable D6: Datasets	
Evidence item	**Relevant section of the report**
Final datasets gathered from the trials for dissemination to stakeholders.	The datasets have been made available to stakeholders via UK Power Networks' open data portal. Instructions for accessing the datasets can be found in Section 5

Optimise Prime is committed to sharing the project's outcomes as widely as possible. The project has been engaging with a wide group of stakeholders throughout the fleet, PHV, technology and energy industries through a programme of events, reports, and the project website www.optimise-prime.com.

The project's next, and final, deliverable detailing the findings from the trials is due to be published in the winter of 2022/3.

1 Background & purpose

This document, which accompanies the sixth deliverable of the Network Innovation Competition (NIC) funded Optimise Prime project, explains the data sets that have been released by the project and provides instructions on how to access the data.

1.1 Introduction to Optimise Prime

Optimise Prime is an industry led EV innovation and demonstration project that brings 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. The role of each partner is described in Table 3.

Table 3 – 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 are project partners. Hitachi Vantara and Hitachi Europe.	Hitachi leads the project, providing overall project management, energy and fleet expertise and project IT platforms. Hitachi is also developing tools for the depot trial.
UK Power Networks	Electricity DNO group covering three licensed distribution networks in South East England, the East of England and London. The three networks serve over 8.4 million customers.	London Power Networks is the project's funding licensee. UK Power Networks provides 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.	Supporting 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 were 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 supports the project's behavioural research activities, provides insight to the fleet market and supported the testing of the project's charging solutions.

Since early 2022, data from the use of over 6,000 EVs driven for commercial purposes has been gathered and analysed. The EVs were primarily based in London and the South East of England, although some in the home trial (WS1) are located throughout the UK. Optimise Prime implemented a range of technical and commercial solutions with the aim of accelerating the transition to electric for commercial fleet operators while helping GB's distribution networks plan and prepare for the mass adoption of EVs. Through cross-industry collaboration and co-creation, the project is aiming to ensure security of energy supply while saving money for electricity customers, helping the UK meet its clean air and climate change objectives and transition to a net zero carbon economy.

Optimise Prime aims to be the first of its kind, paving the way to the development of cost-effective strategies to minimise the impact of commercial EVs on the distribution network. Commercial EVs are defined as vehicles used for business purposes, including the transport of passengers and goods. Compared to vehicles used for domestic purposes, commercial EVs will have a much greater impact on the electricity network because of their higher mileages and therefore higher electricity demand. The additional impact of commercial depot based EVs results from two factors: co-location of multiple EVs at a single depot location, and higher energy demand per vehicle resulting from higher daily mileages and payloads. The latter is also a factor when commercial EVs are charged at domestic locations.

Two DNO groups (UK Power Networks and Scottish & Southern Electricity Networks) across four licence areas are involved in the project. The consortium includes two of the largest UK commercial fleets (Royal Mail and British Gas) and a major PHV operator (Uber). This scale allows the industry to test different approaches to reducing the impact of vehicle electrification on distribution networks, in advance of mass adoption throughout the 2020s. This will also help understand the impact of a wide range of variables on the feasibility of electrifying commercial vehicle fleets, including different network constraints, typical mileage, traffic characteristics, location (urban, sub-urban, rural) and availability of public "top-up" charging. Studying the diversity of fleets will ensure that the learnings generated by the project are applicable to the whole of GB.

Optimise Prime is seeking to answer three core questions, set in the project's Full Submission Pro-Forma (FSP), relating to the electrification of commercial fleets and PHVs:

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 vehicle telematics and network data. This data will enable 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.

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.

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 depot-based, return-to-home fleet and PHV journey data.

Answering these questions will enable network operators to quantify savings which can be achieved through reinforcement deferral and avoidance while facilitating the transition to low carbon transport. The trial will also assess the journey data to understand the charging and associated IT infrastructure requirements and implications for depot and fleet managers to be able to operate a commercial EV fleet successfully.

Optimise Prime is delivering invaluable insights by using data-driven forecasting tools designed to allow networks to proactively plan upgrades. In addition, the project is creating a detailed understanding of the amount of flexibility that commercial EVs can provide to the network through smart charging. Finally, a site planning tool has been developed to allow customers to model the impact of fleet electrification on their connection requirements. The tool shows customers how smart charging could be used to charge their vehicles within existing connection limits. Where smart charging alone is not possible, the tool will provide the information necessary to request profiled connections (a new type of connection, providing a consumption connection capacity limit that varies throughout the day) from the DNO. Taken together, these form a set of innovative capabilities that allow for optimised utilisation of the network capacity, adopting a “flexibility first” approach and only reinforcing the network where no flexible alternative is suitable. This will result in cheaper costs for all electricity bill payers, including those connecting EV CPs.

1.2 Purpose and structure of this document

The purpose of this document is to provide guidance and instructions for project stakeholders and the wider industry to access and use the Optimise Prime project datasets, which have been released as a project deliverable. This data has been generated from the vehicles and infrastructure involved in the Home (WS1), Depot (WS2) and Mixed (WS3) use cases.

The aim of releasing this data is so that the wider electricity, fleet and PHV industry can use the data to optimise their vehicle electrification plans. DNOs, academics and interested parties will be able to utilise this anonymised data created by the project for further research, analysis and forecasting. It can be used to provide real life insights and inform planning and decision-making processes, to ultimately accelerate the transition to EVs and save money for network customers. For example:

- DNOs and regulators may use the data to update their forecasting assumptions around the timing and magnitude of EV demand,
- Charge Point Operators (CPOs) and local authorities may find the data useful to help identify locations underserved by existing charging infrastructure to make investment decisions
- Fleet managers may use the data to plan their charging requirements.

Section 1 provides an introduction to the project and the context of the datasets**.**
Sections 2, 3 and 4 explain for each workstream the data being made available, giving an overview of the individual tables and the meaning of each field.
Section 5 provides instructions on how to access the data.

1.3 Infrastructure, technology solution and trials context

Optimise Prime has been designed to answer the core questions by carrying out three trials, each of which align with the fleets and charging methods of Optimise Prime's three fleet partners (Table 4), and two project methods (Table 5) – specific technical and commercial solutions – are being tested throughout the trials.

Table 4 – Optimise Prime trials

Trial Number	Name	Partner	Description
1	Home Charging	British Gas Maintenance[1]	A field study of charging behaviour and flexibility with a return to home fleet.
2	Depot Charging	Royal Mail Delivery	A field study of charging behaviour and flexibility with a depot-based fleet. Additionally, the testing of profiled connections.
3	Mixed Charging	Uber PHV operator	A study based on analysis of journey data from electric PHVs.

Table 5 – Optimise Prime methods

Method 1 **Smart demand response for commercial EVs on domestic connections**	Currently the additional peak demand would trigger reactive network reinforcement with the costs being entirely socialised as domestic and non-domestic use is blended together. In Optimise Prime we aim to separate the commercial loads to make them visible, testing demand response approaches with commercial EVs charging at domestic premises to identify and quantify the available charging flexibility.
Method 2 **Depot energy optimisation and planning tools for profiled connections**	Currently depots request a connection based on 'worst case' estimated peak demand, often triggering network reinforcement. The cost is part paid for by the connecting customer and part socialised across connected customers. In Optimise Prime we aim to design and test smart charging and energy optimisation 'behind the meter', at depots, to be able to conform to an agreed profiled connection. We are developing the tools and processes to calculate the optimal connection profile and infrastructure, for each site, to minimise the connection cost and/or capacity used. We will also test demand response approaches to identify and quantify the available charging flexibility from an optimal profile. The project will develop the commercial arrangements to enable the rollout of the method following the project.

1.3.1 The trials' data

The trials data being released as part of the project includes much of the raw data directly captured by the project, including telematics and charging data. This mostly consists of tables of events and measures recorded during the trials. Figure 1 gives an overview of the structure

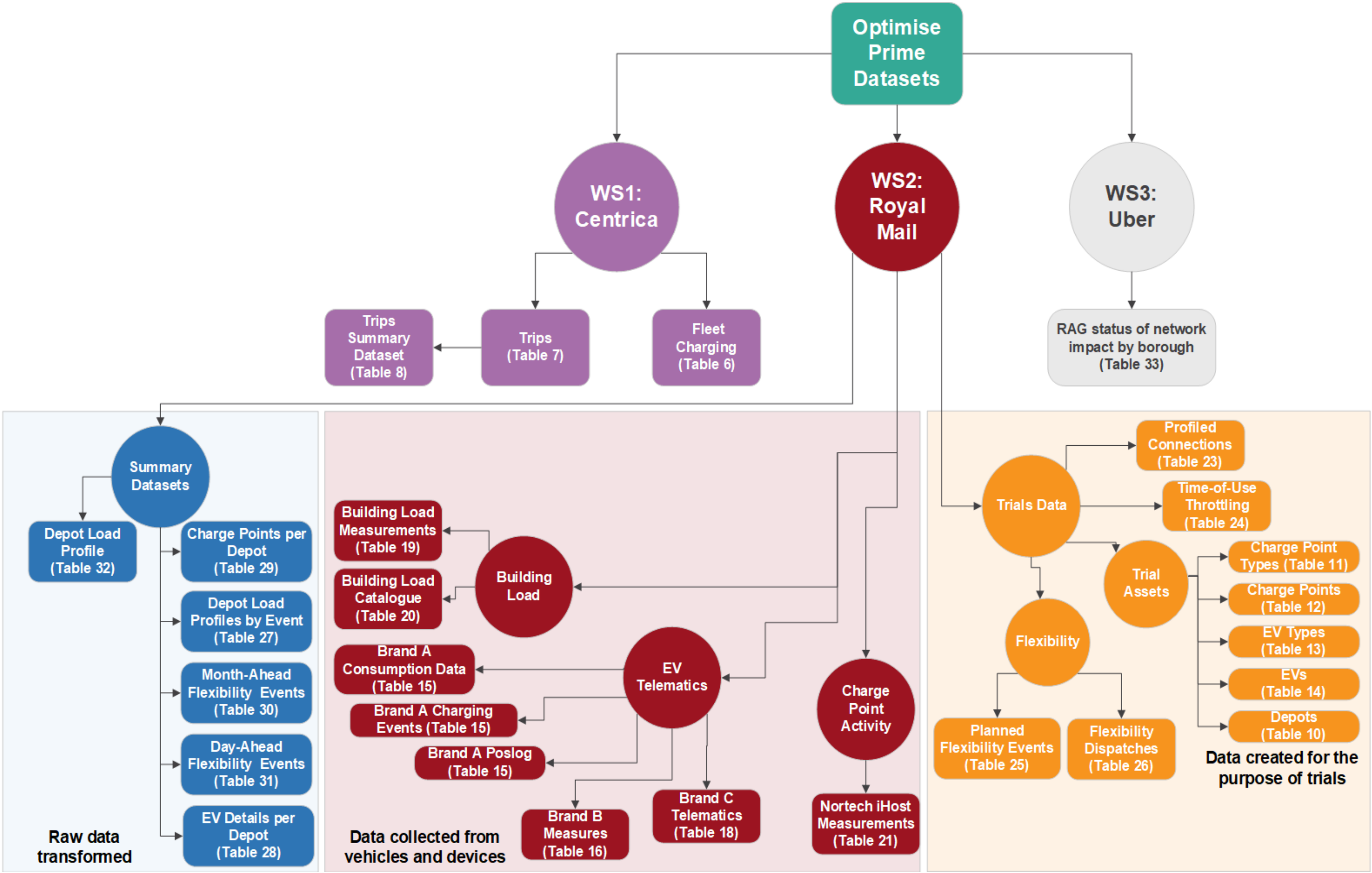
[1] British Gas is a subsidiary of project partner Centrica.

of the data, which is explained in detail in the following chapters. The table numbers in the diagram refer to the tables in this document.

Analysis, insights, and conclusions based on the raw trial data, will be published as part of Deliverable D7.

The core trials period for the project covered the period 1 July 2021 to 30 June 2022, during which the minimum number of vehicles were in place for each fleet. The dataset principally contains data collected during this trial period. Additionally, data from before 1 July 2021 has been included in the dataset where available.

Figure 1 – Schematic of the Optimise Prime datasets



2 WS1 Data (Home trial)

WS1 was the home charging trial, which gathered EV and charging data from British Gas EVs operating throughout the UK. The data being made available in the Optimise Prime dataset is comprised of two distinct tables covering charging and journeys. Journey data is only shown to an outward postcode level to protect the personal data of British Gas drivers and customers. The charging and trips data are shown in separate tables, and it is not possible to correlate charging and trip events.

The number of British Gas EVs increased throughout the trials, from around 300 in July 2021 to over 1,000 in June 2022. The number of active CPs increased in a similar proportion, though there are slightly fewer CPs than EVs in the data, as it was not possible to install CPs at all drivers' homes, resulting in some drivers using public charging.

The EVs in the trial are all Vauxhall Vivaro-e vans, while the CPs are single socket and generally capable of 32A/7.4kW charging.

2.1 British Gas EV fleet charging data

The British Gas EV fleet charging data is captured from the CPs at drivers' homes. It captures each time an EV was plugged into a CP, the start and end of each charging event, the duration of each plug-in or charging session and the energy delivered in each event. Each field in the data is explained in Table 6.

Table 6 – bg_fleet_charging – British Gas EV fleet charging data

Column	Data type	Description
ingestion_id	bigint	The ingestion ID uniquely identifies each file
charger_id	character varying	ID of the charger
transaction_id	integer	ID of the Transaction (charging event)
start_date_time	timestamp with time zone	Start timestamp of charging event
end_date_time	timestamp with time zone	End timestamp of charging event
charge_duration	character varying	Duration of charging event in hours and minutes (hh:mm:00)
charge_duration_minutes	integer	Duration of charging event in minutes
total_kwh	numeric	Total kWh of the charging event
plug_duration	character varying	The time the EV was plugged in to the CP, in the format hh:mm*
plug_duration_minutes	integer	The time the EV was plugged in to the CP, in minutes*

* plug_duration and plug_duration_minutes was sometimes not received from the data source. Where this was the case, these fields are left blank in the dataset.

2.2 British Gas EV fleet trips data

The British Gas EV trips data is sourced from British Gas's telematics system. It details the start and end time and location of each trip carried out by the EVs, together with the distance travelled on each trip. Each field in the data is explained in Table 7. For purposes of anonymity only the first half of postcodes are given in the data.

Table 7 – bg_trips – British Gas EV fleet trips data

Column	Data type	Description
ingestion_id	bigint	The ingestion ID uniquely identifies each file
date_key	numeric	Date key
device_screen_name	character varying	Uniquely identifies a telematics device
start_time_key	numeric	Start time key
end_time_key	numeric	End time key
start_timestamp_utc	timestamp without time zone	Start timestamp of trip
end_timestamp_utc	timestamp without time zone	End timestamp of trip
start_date	date	Start date of trip
end_date	date	End date of trip
distance_trip_miles	numeric	Distance travelled in trip in miles
start_post_code	character varying	First half post code of start of trip
end_post_code	character varying	First half post code of end of trip

The British Gas EV fleet data has been summarised for each EV, to include key information such as start and end times, distance traveled, and vehicle ID. Table 8 provides a description of the fields included in the dataset, which covers both the ICE and EV fleet.

Table 8 – aggregated shift telematics data

Column	Data type	Description
vehicle_id	integer	A unique identifier for the vehicle that generated the data
start_timestamp_utc	timestamp without time zone	The UTC date and time when the vehicle started its shift
end_timestamp_utc	timestamp without time zone	The UTC date and time when the vehicle finished its shift
shift_distance_miles	numeric	The total distance (in miles) driven by the vehicle during the shift

Column	Data type	Description
is_ev_bool	character varying	A Boolean value that indicates whether the vehicle is electric or not (TRUE if it is electric, FALSE otherwise)
home_loc_definition	character varying	A string that defines the type of location where the vehicle is kept at night, such as "Suburban" or "Urban"
schedule_profile	character varying	A string that indicates the type of schedule assigned to the vehicle, such as "Standard" or "Long Day"

3 WS2 Data (Depot trial)

The WS2 data relates to the depot charging trials conducted at Royal Mail depots. In order to conduct these trials, data was collected to enable analysis of different aspects relevant to optimisation, namely:

- Asset data – static data giving specifications of depots, CPs and EVs
- Building load measurements
- CP data
- Telematics data
- Trials configuration data, detailing when interventions such as flexibility and profiled connections were carried out.

These datasets are described in more detail in the following sections.

3.1 Trial assets

Optimise Prime catalogued the assets that were part of the trials, using a purpose-built Hitachi system.

All transactions to create, update or delete a CP or EV were recorded, so that a historical view of this data is possible. The same applies for Charge Point Types data that record the specifications of the CPs. This approach allows a record, at a certain point in time, of how the asset was configured. For instance, a CP can be included or removed from optimisation during the trials; with this approach it is possible to determine in which periods, if any, the CP was removed from optimisation. Throughout the trial period there was no addition or removal of physical CPs at Royal Mail depots.

In order to view the assets in place at the end of the trials, the most recent version of the trial asset data should be used.

3.1.1 Overview of Trial Assets

Figure 2 reflects the logical relationship between asset entities and highlights how the tables in the data are connected. Please note that this is a logical diagram and may not reflect the physical implementation. Table 9 describes each of the asset types.

Figure 2 – Logical relationship between assets and tables

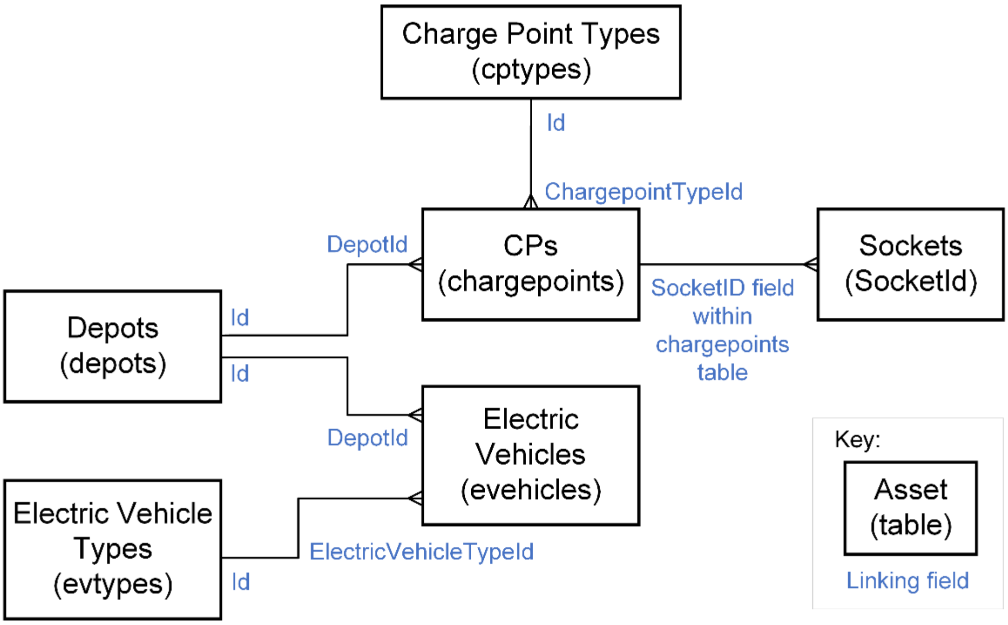


Table 9 – Overview of trial assets

Asset type	Description
Depot	The building where the CPs are located and the EVs are based
Charge Point	An electrical charging station equipped with one or more sockets to provide charging capability to electrical vehicles
Socket	The part of the Charge Point where a cable can be attached to connect to an EV
EV	An Electric Vehicle
EV type	Identifies the characteristics of a combination of make/model. This includes for example the battery capacity and maximum supported charge rate.

3.1.2 Depots

Depot data is stored in the table 'depots'. Table 10 explains the format of the information in this table. Each message records the creation, update or deletion of a depot. The blue text in the example message describes the meaning of each field.

Table 10 – 'depots' data table

<table>
<tr><th>Column</th><th>Data Type</th><th colspan="2">Description</th></tr>
<tr><td>timestamp</td><td>bigint</td><td colspan="2">timestamp in Unix format in milliseconds</td></tr>
<tr><td>offset</td><td>bigint</td><td colspan="2">The order in which the record was created, uniquely identifies each field</td></tr>
<tr><td>key</td><td>string</td><td colspan="2">Identifies a Depot uniquely. In the format toa.depot.[depot ID]. E.g. toa.depot.1</td></tr>
<tr><td rowspan="13">message</td><td rowspan="13">string</td><td colspan="2">The json containing the details of the transaction.
Example:</td></tr>
<tr><td>{"id":9,</td><td>#Internal depot id</td></tr>
<tr><td>"operation":"Update",</td><td>#Whether this is creating, updating or deleting a depot</td></tr>
<tr><td>"timestamp":"01/31/2022 09:22:51 +00:00",</td><td>#Timestamp of the insert/update/delete to the depot</td></tr>
<tr><td>"Type":"Physical",</td><td>#Depot type</td></tr>
<tr><td>"DNORegion":"UKPN",</td><td>#Depot DNO Region</td></tr>
<tr><td>"ConnectionPointKVA":245,</td><td>#Depot connection limit (ASC) in kVA</td></tr>
<tr><td>"BufferKW":10,</td><td>#Configured buffer in kW to determine the maximum capacity of the depot for optimisation. The buffer is subtracted from the depot capacity for headroom calculation[2]</td></tr>
<tr><td>"EnergyAvailableWarning":25
,</td><td>#Allows configuration of thresholds to create warnings when headroom available is lower than this percentage</td></tr>
<tr><td>"EnergyAvailableError":10,</td><td>#Allows configuration of thresholds to create errors when headroom available is lower than this percentage</td></tr>
<tr><td>"PowerMeterId":63746,</td><td>#The site_id to map to Panoramic Power data. The sum of power measured in devices under this id measure the total building load</td></tr>
<tr><td>"ApplyProfiledConnectionOpti
misation":true,</td><td>#Indicates if the configured profiled connections for the depot should be applied or not to the depot</td></tr>
</table>

[2] Headroom is the amount of power available for charging EVs. This is generally calculated by taking background load away from the ASC (minus the buffer specified in the depots table). Where flexibility is being offered headroom is based on the flexibility offer that has been accepted.

Column	Data Type	Description	
		"ApplyFlexibilityOptimisation": false,	*#indicates if the configured flexibility events should be applied to the depot or not*
		"ApplyPrioritisationOptimisation":false,	*#Indicates if the configured prioritisation parameters should be applied to the depot or not*
		"SendTestMessages":false	*#Indicates if the control requests being sent to the depot should be test messages or not. Test messages are not actioned by the CPs*
		"HeadroomAlgorithmId":2	*#Internal only*
		"ScheduleWeightRate":0.0	*#Not in use*
		"SOCWeightRate":100.0	*#Not in use*
		"FleetId":1,	*#Not in use*
		"IsDeleted":false,	*#Whether the depot has been deleted from the system*
		"DeletedTimestamp":null,	*#The date and time the depot was deleted. Null if the depot is still active*
		“CreatedTimestamp":"06/21/2021 12:13:20 +00:00",	*#The date and time the depot was created in the system*
		"UpdatedTimestamp":"01/31/2022 09:22:51 +00:00"}	*#The date and time the depot data was last modified*

3.1.3 Charge Point Types

Charge Point Types data is stored in the table cptypes. This data sets the specification of each model of CP in use at the depots. Depots can share Charge Point Types and have multiple of each Charge Point Type – this is recorded in the Charge Points table. The content of the messages in this table is explained in Table 11.

Table 11 – 'cptypes' data table

Column	Data Type	Description	
offset	bigint	The order in which the record was created, uniquely identifies each field	
timestamp	bigint	timestamp in unix format in milliseconds	
key	string	Identifies uniquely a CP type. In the format toa.chargepointtype.**[CP Type ID].** e.g. toa.chargepointtype.1	
message	string	The json containing the details of the transaction. Example:	
		{"id":1,	*#Internal charge point type ID*
		"operation":"Insert",	*#Whether this is creating, updating or deleting a CP type*
		"timestamp":"06/02/2021 09:48:49+00:00",	*#Timestamp of the operation*
		"Phase":"Single",	*#Phase - Single or Triple*
		"RatingKW":7.4,	*#Maximum charge rate of the CP, kW*
		"MinRatingKW":1.4,	*#Minimum charge rate of the CP, kW*
		"Sockets":"One",	*#Number of sockets in the CP*
		"ConnectorType":"Type2",	*#Connector type*
		"IsDeleted":false,	*#Whether the CP type has been deleted from the system*
		"DeletedTimestamp":null,	*#The date and time the CP type was deleted. Null if the CP type is still active*
		"CreatedTimestamp":"06/02/2021 09:48:49 +00:00",	*#The date and time the CP type was created in the system*
		"UpdatedTimestamp":null}	*#The date and time the CP type data was last modified*

3.1.4 Charge Points

CP data is stored in the table ‘chargepoints’. Each CP is stored individually and linked with a Depot and a Charge Point Type. Table 12 explains each of the fields in the ‘chargepoints’ table.

Table 12 – 'chargepoints' data table

Column	Data Type	Description	
offset	bigint	The order in which the record was created, uniquely identifies each field	
timestamp	bigint	timestamp in Unix format in milliseconds	
key	string	Uniquely identifies a CP. In the format toa.chargepoint.**[CP ID].** e.g. toa.chargepoint.1	
message	string	The json containing the details of the transaction. Example:	
		{"id":1,	*#Charge Point internal ID*
		"operation":"Insert",	*#Whether this is creating, updating or deleting a CP*
		"timestamp":"06/02/2021 09:48:57 +00:00",	*#Timestamp of the operation*
		"Name":"evc0011",	*#CP name*
		"EVSESerialNumber":"evc0011",	*#Serial number*
		"OCPPVersion":"OCPP Version 1",	*#OCPP version used by the CP*
		"FirmwareVersion":"Firmware Version 1",	*#Firmware version used by the CP*
		"DepotId":1,	*#Depot ID of depot where CP is installed (see depots table)*
		"ChargePointTypeId":3,	*#Charge Point type ID (see cptypes table)*
		"ApplyOptimisation":false,	*#Indicates whether the CP should be included for optimisation*
		"IsDeleted":false,	*#Whether the CP has been deleted from the system*
		"DeletedTimestamp":null,	*#The date and time the CP was deleted. Null if the CP is still active*
		"CreatedTimestamp":"06/02/2021 09:48:57 +00:00",	*#The date and time the CP was created in the system*
		"UpdatedTimestamp":null,	*#The date and time the CP data was last modified*
		"SocketId":"skt1"}	*#The sockets associated with this charge point*

3.1.5 EV Types

EV Types data is stored in the table ‘evtypes’. This data stores the specification of each type of EV involved in the trials. Table 13 explains each field in the ‘evtypes’ table.

Table 13 – ‘evtypes’ data table

Column	Data Type	Description	
offset	bigint	The order in which the record was created, uniquely identifies each field	
timestamp	bigint	timestamp in Unix format in milliseconds	
key	string	Uniquely identifies an EV Type. In the format toa.evtype. **[ev type ID].** e.g. toa.evtype.1	
message	string	The json containing the details of the transaction. Example:	
		{"id":7,	*#EV type internal ID*
		"operation":"Insert",	*#Whether this is creating, updating or deleting an EV type*
		"timestamp":"11/29/2021 13:13:54 +00:00",	*#Timestamp of the operation*
		"BatteryCapacityKWh":50.0,	*#Battery capacity in kWh*
		"MinChargeRateKW":0.7,	*#Minimum charging rate for the EV type*
		"MaxChargeRateKW":7.3,	*#Maximum charging rate for the EV type*
		"MaxStateCharge":100,	*#Maximum state of charge for EV type*
		"IsDeleted":false,	*#Whether the EV type has been deleted from the system*
		"DeletedTimestamp":null,	*#The date and time the EV type was deleted. Null if the EV type is still active*
		"CreatedTimestamp":"11/29/2021 13:13:54 +00:00",	*#The date and time the EV type was created in the system*
		"UpdatedTimestamp":null}	*#The date and time the EV type data was last modified*

3.1.6 EVs

EV data is stored in the table 'evehicles'. This data contains records for each vehicle in the trials, linking each with a Depot and EV type. Table 14 explains the fields in the EV 'evehicles' table.

Table 14 – 'evehicles' data table

<table>
<tr><th>Column</th><th>Data Type</th><th colspan="2">Description</th></tr>
<tr><td>offset</td><td>bigint</td><td colspan="2">The order in which the record was created</td></tr>
<tr><td>timestamp</td><td>bigint</td><td colspan="2">timestamp in Unix format in milliseconds</td></tr>
<tr><td>key</td><td>string</td><td colspan="2">Uniquely identifies an EV. In the format toa.electricvehicle.[EV ID].
e.g. toa.electricvehicle.1</td></tr>
<tr><td rowspan="13">message</td><td rowspan="13">string</td><td colspan="2">The json containing the details of the transaction.
Example:</td></tr>
<tr><td>{"id":211,</td><td>#Internal EV ID</td></tr>
<tr><td>"operation":"Insert",</td><td>#Whether this is creating, updating or deleting an EV type</td></tr>
<tr><td>"timestamp":"06/17/2021 20:37:57 +00:00",</td><td>#Timestamp of the operation</td></tr>
<tr><td>"ChargingTagId": "920D2CF4"</td><td>#Authorisation ID used to identify the EV is connected to a certain CP (see "tag_id" in nortech_ihost_measurements table)</td></tr>
<tr><td>"RegistrationDate": "01/2020"</td><td>#Registration Date of the EV</td></tr>
<tr><td>"DepotId":4,</td><td>#Depot ID of depot EV is associated with (see depots table)</td></tr>
<tr><td>"ElectricVehicleTypeId":1,</td><td>#EV Type for this vehicle (see toas_proc.evtypes table)</td></tr>
<tr><td>"IsDeleted":false,</td><td>#Whether the EV has been deleted from the system</td></tr>
<tr><td>"DeletedTimestamp":null,</td><td>#The date and time the EV was deleted. Null if the EV is still active</td></tr>
<tr><td>"CreatedTimestamp":"06/17/2021 20:37:57 +00:00",</td><td>#The date and time the EV was created in the system</td></tr>
<tr><td>"UpdatedTimestamp":null}</td><td>#The date and time the EV data was last modified</td></tr>
</table>

3.2 Telematics

The EVs involved in the WS2 trials included three different telematics sources, depending on vehicle make and age. The data from these telematics systems are referred to as 'Brand A', 'Brand B' and 'Brand C'.

Due to the different systems used, the granularity of the data, available attributes and formats differ between the sources. The data is also stored in different tables. The following sections describe the structure and contents of the telematics data.

3.2.1 Brand A Telematics

The telematics data from vehicles using Brand A telematics comprises the following tables which are linked by the 'id' field:

- **brand_a_poslog_gp** – contains details of the geographical positions of vehicles
- **brand_a_charging** – contains EV charging related information
- **brand_a_consumption** – contains vehicle trip distances and electricity consumption

Table 15 – 'Brand A' telematics data tables

Column	Data type	Description
brand_a_poslog_gp		
ingestion_id	bigint	Timestamp in numeric format of when data was ingested.
device_id	character varying	The device id to search on.
id	bigint	The Poslog ID.
meter_counter	bigint	The distance, in meters, from the device initialisation or the distance reported by the vehicle when connected in CAN Bus.
gsm	character varying	Indicates if the GSM was enabled or not when the position was generated (true is enabled, false is disabled).
ksw	character varying	Indicates the +12KSW (Kinneret Smart Waves) telematics antenna state (true is ON, false if OFF).
utc	character varying	Defines when the position was generated in User issuing the request time zone time. (UTC in the Optimise Prime case).
speed	numeric	The speed of vehicle movement in km/h. A special value of 252 identifies an undetermined value.
reason	bigint	Describes the reason of this Poslog production. There are 4 possible reasons: • 0: forced – loss of GPS signal or other conditions requiring the device to do so. • 1: speed – speed changes. • 2: distance – the distance covered since the last position was produced. • 3: angle – bearing changes.
received	timestamp without time zone	Defines when the position was received by the server in User's issuing the request time zone time.
ev_id	int	The Hitachi system internal EV ID. Used for cross referencing with the EV assets table

Column	Data type	Description
brand_a_charging		
ingestion_id	bigint	Timestamp in numeric format of when data was ingested.
device_id	character varying	The device ID to search on.
id	bigint	Position ID.
meter_counter	bigint	The distance, in meters, from the device initialisation or the distance reported by the vehicle when connected in CAN Bus.
gsm	character varying	Indicates if the GSM was enabled or not when the position was generated (true is enabled, false is disabled).
ksw	character varying	Indicates the +12KSW (Kinneret Smart Waves) telematics antenna state (true is ON, false if OFF).
utc	timestamp without time zone	Defines when the position was generated in User issuing the request's time zone time. (UTC in the Optimise Prime case).
received	timestamp without time zone	Defines when the position was received by the server in User's issuing the request time zone time.
ngp_payload_plug_connected	character varying	True if the vehicle is connected to an electrical plug.
ngp_payload_hv_battery_low	character varying	True if the high voltage battery level is low. It has been observed that the telematics data source has not always sent data for this parameter – where this is the case the field is blank.
ngp_payload_hv_battery_is_charging	character varying	True if the high voltage battery is being charged.
ngp_payload_charging_type	bigint	Charging type (0=unknown, 1=10A, 2=16A, 3=fast).
ngp_payload_charging_power	bigint	Charging power in kW. When payload_charging_type is 0 (unknown), assumes a null or 31 value, which should be interpreted as unknown.
ngp_payload_energy_level	bigint	State of charge (percentage, 127=unavailable).
ngp_payload_remaining_time	bigint	Remaining time before full charge (minutes, 0xFFFF=unavailable).
ngp_payload_autonomy	bigint	Vehicle range in km (0xFFFF=unavailable).
ev_id	int	The Hitachi system internal EV ID. Used for cross referencing with the EV assets table
brand_a_consumption		
ingestion_id	bigint	Timestamp in numeric format of when data was ingested
device_id	character varying	Telematics device ID.
id	bigint	Position ID.
meter_counter	integer	The distance, in meters, from the device initialisation or the distance reported by the vehicle when connected in CAN Bus.

Column	Data type	Description
gsm	character varying	Indicates if the GSM was enabled or not when the position was generated (true is enabled, false is disabled).
ksw	character varying	Indicates the +12KSW (Kinneret Smart Waves) telematics antenna state (true is ON, false if OFF).
utc	timestamp	Defines when the position was generated in User's issuing the request time zone time (UTC in the Optimise Prime case).
received	timestamp	Defines when the position was received by the server in User's issuing the request time zone time.
ngp_payload_vehicle_electric_consumption_trip_hm	integer	Trip distance in hectometers (hm). It has been observed that the telematics data source has sometimes returned a zero value even though battery is being consumed.
ngp_payload_vehicle_electric_consumption_gauge	numeric(6,1)	Percentage of the battery charge used (A value of 127 means that the battery level is not available).
ngp_payload_vehicle_electric_consumption_kwh	integer	Describes the amount of used energy in kWh
ev_id	int	The Hitachi system internal EV ID. Used for cross referencing with the EV assets table

3.2.2 Brand B Telematics

Data from vehicles using the Brand B telematics is stored in the brand_b_measures table described in Table 16. There is a different entry for each type of measure, identified by the 'attributename'.

Table 16 – 'Brand B' telematics data table

Column	Data_type	Description	
ingestion_id	bigint	Timestamp in the numeric format of when data was ingested.	
attributename	character varying	Measure's attribute name. The following is a list of attribute names that can be found in this column. Due to a system change at the telematics provider, data prior to August 2021 has a slightly different attribute list, with the possible attributes listed in Table 16.	
		Driving.Odometer.Lifetime	#The distance the EV has travelled in its lifetime, km
		Driving.StateOfCharge.Departure	#State of Charge when the journey began
		ElectricalDrive.Charging.EndOfChargingTime	#Predicted end of charging time
		ElectricalDrive.Charging.IsActive	#Whether the EV is charging
		ElectricalDrive.Charging.Power	#The rate at which the EV is charging in KW
		ElectricalDrive.Charging.Status	#Charging status
		ElectricalDrive.HighVoltageBattery.StateOfCharge	#The State of Charge at the time of the measure
		Preconditioning.IsActive	#Whether the vehicle is in preconditioning mode
		Preconditioning.ScheduledTime	#If scheduled, when preconditioning mode will run
category	character varying	Value of serviceId from the API	
measure_timestamp	timestamp without time zone	Timestamp of the measure	
measure_time_offset	integer	Time offset. Only applies to the SoC profile attribute	
measure_value	numeric	Measures numeric value associated with the specified attribute name. Various measures are possible (e.g. SoC %; Odometer km)	
measure_value_string	character varying	For certain attributes, the measure value is a string indicating state. In this case, the measure_value_string is used.	
ev_id	int	The Hitachi system internal EV ID. Used for cross referencing with the EV assets table	

Table 17 – 'Brand B' measure names pre-August 2021

Measure names pre-August 2021		
rangeElectric	Preconditioning.IsActive	ElectricalDrive.Charging.EndOfChargingTime
chargingStatus	precondError	chargingPower
precondAtDeparture	departureTime	Driving.StateOfCharge.Departure
electricConsumptionReset	distanceElectricalReset	ElectricalDrive.Charging.Power
distanceElectricalStart	electricConsumptionStart	maxRange
ElectricalDrive.HighVoltageBattery.StateOfCharge	ElectricalDrive.Charging.IsActive	endOfChargeTime
electricalRangeSkipIndication	ElectricalDrive.Charging.Status	departureTimeMode
chargingActive	Driving.Odometer.Lifetime	Preconditioning.ScheduledTime
odometer	soc	departureTimeSoc
precondActive		

3.2.3 Brand C Telematics

Some EVs, mainly those which were in the fleet before the trials began, were fitted with Brand C telematics which provides more limited data, as described in Table 18.

Table 18 – 'Brand C' telematics data table

Column	Data type	Description
device_screen_name	string	Uniquely identifies a telematics device
date	date	Date the data refers to
time	time	Time the data refers to
timezone	string	Time zone of the data
timestamp_utc	timestamp	Timestamp in UTC
speed	numeric	The speed at which the EV was travelling (mph)
direction	string	The direction the EV was travelling towards
duration	numeric	Duration of the trip (minutes)
distance_trip_miles	numeric	The distance of the trip in miles (incremental)
ingestion_id	int	The date and time when data was ingested

3.3 Building load

Building load data for the Royal Mail depots involved in the Optimise Prime trials is provided in the dataset, sourced from Panoramic Power measurement devices installed at each depot. The Building Load Measures table contains minute by minute measures of the building load from monitoring devices located at each depot. Additionally, the Building Load Catalogue (Section 0) is required to map the devices to a specific depot. The number of devices at each depot varies due to the differing complexity of the Royal Mail depots' electrical installations.

3.3.1 Building Load Measures

This table holds data reported by the devices monitoring building load at a one-minute frequency. The columns are described in Table 19.

Table 19 – building_load_measures data table

Column	Data type	Description
ingestion_id	bigint	Timestamp in the numeric format of when data was ingested
device_id	bigint	Device ID
site_id	bigint	Site ID (refers to depots in Table 10)
measurement_time_utc	timestamp without time zone	The timestamp when the measurement was taken
resolution_minutes	bigint	How many minutes the measurement refers to
current_a	numeric(20,15)	The recorded amperage for the device
voltage_v	numeric(20,15)	The recorded voltage for the device
power_w	numeric(20,15)	The real power recorded for the device
power_factor	numeric(20,15)	The power factor recorded for the device
energy_wh	numeric(20,15)	The energy consumption recorded by the device

3.3.2 Building Load Catalogue

This table gives details of the sites where load monitoring is taking place, corresponding to the 'site_id' field in the 'building_load_measures' table. The columns are described in Table 20.

Table 20 – building_catalog data table

Column	Data type	Description
sequence_sk	integer	Sequential number that uniquely identifies each item in the building catalogue
ingestion_id	bigint	Timestamp in the numeric format of when data was ingested.
zone_id	integer	A unique identifier of the physical zone in which the device is located. Note that a single site, may contain multiple zones
zone_name	character varying	The zone's name as assigned at installation time.
site_id	integer	A unique identifier of the physical site in which the device is located.
site_name	character varying	The site's name as assigned at installation time.
panel_id	integer	A unique identifier of the physical panel in which the device is located. Note that a single zone, may contain multiple panels.
panel_name	character varying	The panel's name as assigned at installation time. For example, "Panel 54-A".
device_id	integer	The device id to search on
device_name	character varying	The device name
device_category	character varying	Type of the device according to its group main functionality. For example, "Mains", "Heating and Cooling", "Lighting", etc.
device_type	character varying	Type of the device according to its main functionality.
device_electrical_type	character varying	Device number of phases and deployed sensors.
device_description	character varying	The entity's description as assigned at installation time.
valid_from	date	The beginning of the date range.
valid_to	date	The end of the data range.
created_date	date	Date that device was created
updated_date	date	Date that was updated
version	integer	Device version

3.4 CP data

In order to analyse the charging behaviours at Royal Mail's depots, the CPs monitor and record a range of measurements regarding their status and the power delivered in charging sessions. CPs communicate in near real time with the Optimise Prime platform.

3.4.1 CP measurements

iHost is the system responsible for gathering measurements from the CPs. In near real time, those messages are sent to Optimise Prime's platform and queued for later ingestion. The measurements are then gathered, duplicates are removed and measures are then stored in the nortech_ihost_measurements table described in Table 21.

Table 21 – nortech_ihost_measurements data table

Column	Data type	Description
ingestion_id	character varying	A numeric timestamp in YYYYMMDDhhmmss of when data was ingested.
evse_serialnumber	character varying	The EVSE (CP) serial number is used as reported by the EVSE in the OCCP Boot Notification.
socket_id	character varying	The socket ID is the string literal "skt" following by the ordinal socket number on the EVSE. The EVSE used for the Optimise Prime project currently support either 1 or 2 sockets, so they would be named as follows: skt1 or skt2
datapoint_type	character varying	The datapoint type of the received measurement. Data point types available can be found in the "Data Point Types" table, Section 3.4.2. Data point types are received by the Hitachi system at intervals of 1 minute. If the measurement has not been updated since the last reporting it is deduplicated and only the original measurement is kept
measure_timestamp_utc	timestamp without time zone	The measurement timestamp converted to UTC time
measure_value	numeric	Measurement value as IEEE 754 double precision floating point number and in engineering units. Shows measure value where datapoint_type refers to a numeric value. Total energy (Wh), Real Power (kW), Current Limit (amps - I)
measure_value_boolean	boolean	Binary value where false = open and true = closed Shows values where datapoint_type refers to a boolean value
measure_value_string	character varying	UTF-8 string value Shows values where datapoint_type refers to a string value
value_quality	character varying	Quality of value, enumeration. 0 = Good 1 = Invalid 2 = Suspect

Column	Data type	Description
received_timestamp_utc	timestamp without time zone	Timestamp in UTC when message was received in the Hitachi system
tag_id	character varying	Value reported over OCPP a token_id

3.4.2 Data Point Types

The data point types that can be sent to the Optimise Prime platform in the 'datapoint_type' field include are described in Table 22.

Table 22 – Explanation of data point types in the nortech_ihost_measurements data table

Data Point Type	Data Type	Value Representation
available	boolean	Default state: RFID card not yet scanned/EV disconnected
preparing	boolean	RFID card authorised, no EV connected (cable can be connected to CP with no EV on the other end)
unavailable	boolean	Momentary between skt1.preparing and skt1.suspendedEv
suspendedev	boolean	EV connected and authorised but not charging. This state will occur once the EV battery has become fully charged.
charging	boolean	EV is charging
finishing	boolean	Charging session cancelled by scanning RFID card but EV still connected
reserved	boolean	When a reservation for a specific idtag is in place
suspendedevse	boolean	When power is not being supplied at the request of the EVSE (e.g. due to a smart charging event).
faulted	boolean	A fault occurred at the CP
totalenergy	double	Value in kWh, the meter measuring energy delivered by the EVSE
realpower	double	Value in kW, the power being delivered by the EVSE to the connected EV at the time of the measurement
currentlimit	double	Value in A, the setpoint that is currently limiting the amount of power the EVSE can deliver to the connected EV
idtag	string	Value reported over OCPP as token_id (the device used to authenticate a charging session, typically the RFID). A message of [comms lost] can also be present in this message type.

When analysing real power, current limit and total energy measures, it is important to note that variations may occur due to the Optimise Prime platform performing an optimisation during that period.

In order to understand which optimisations were in effect at a certain period of time, the trials configurations datasets are provided. Constraints applied to a certain depot, such as profiled connections, flexibility events and time of use tariff-based throttling are recorded for this purpose and are described in section 3.5.

3.5 Trials configuration data

Optimise Prime's trials are configured using a Hitachi system designed specifically for this purpose. This system records a number of distinct configurations necessary to perform the trials:

- **Profiled connection configurations –** profiled_connections
- **Time of Use Tariff throttling –** time_of_use_throttlling
- **Flexibility events –** planned_flexibility_events and **dispatches** flexibility_dispatches

Similar to assets, each configuration change recorded in the previously mentioned Hitachi system is recorded in these tables.

All three trial configurations impact charging sessions in the same way; available headroom for charging is calculated and split between the active sockets. The charge speed of each socket is limited by setting the 'currentlimit' so that it does not exceed the capacity available for charging. To prevent impact on Royal Mail operations, and technical problems caused by some chargers, the minimum 'currentlimit' applied to each active socket is generally 6A (~1.5kW).

3.5.1 Profiled Connections

The profiled connections table, explained in Table 23, details the dates profiled connections were in place. Profiled connections place a capacity limit on a site (including both EV and background load) potentially varying at a 30-minute granularity. When site load nears this capacity, EV load is reduced in order to avoid a breach.

Table 23 – profiled_connections data table

Column	Data type	Description	
offset	bigint	The order in which the record was created	
timestamp	bigint	timestamp in Unix format in milliseconds	
key	string	Identifies uniquely a Profiled Connection.	
message	string	{ "profiledConnectionPlanId":52,	*#ID of the profiled connection plan, a collection of connection limits covering different time periods at a depot*
		"profiledConnectionId":192,	*#ID of the profiled connection, a single time period/capacity combination.*
		"depotId":6,	*#Internal ID of the depot the profiled connection plan applies to (refer to depots,* Table 10*)*
		"operation":"Insert",	*#records the creation, update or deletion of a profile*
		"timestamp":"01/19/2022 13:53:04 +00:00",	*#Timestamp of the operation*
		"startDate":"01/20/2022 00:00:00 +00:00",	*#Date when the profiled connection will start being applied*
		"endDate":"06/27/2022 00:00:00 +00:00",	*#Date when the profiled connection will stop being applied*
		"startTime":"13:00:00",	*#Time when the profiled connection will start being applied*
		"endTime":"17:00:00",	*#Time when the profiled connection will stop being applied*
		"daysOfWeek":["Monday"],	*#Weekdays when the profiled connection will be applied*
		"valueKVA":167 }	*#Maximum capacity defined by the profiled connection in kVA*
		In this example, a profiled connection has been configured for the Depot with ID 6 in the system. This profiled connection was configured to start on 20 January 2022 and run until the 27 June 2022. It limits the capacity of the depot to 167 kVA on Mondays between 13:00 and 17:00. The timestamp reference in the json data relates to when the configuration was done. Please note that the configuration can be changed, so in order to understand which profiled connection was valid at the time, this will need to be taken into consideration	

3.5.2 Time of Use configuration

Time-of-use throttling allows a site to reduce EV charging load at specific times of day when electricity costs are highest. The constraint is entered as a percentage reduction in controllable EV load. At the Royal Mail sites, CPs were set at a minimum rate of 6A in order to prevent disruption risk to operations, therefore a 100% reduction corresponds to connected EVs charging at 6A, while 0% would allow charging at full rate and 50% would result in charging at a rate halfway between the minimum and maximum rates. Table 24 explains how time-of-use events are stored in the dataset.

Table 24 – time_of_use_throttling data table

Column	Data type	Description	
offset	bigint	The order in which the record was created	
timestamp	bigint	timestamp in Unix format in milliseconds	
key	string	Identifies uniquely a Time of Use configuration.	
message	string	{ "electricityTariffPlanId":8,	*#Internal ID of the time of use (electricity tariff) optimisation plan*
		"throttleId":44,	*#Internal id of the time of use (electricity tariff) optimisation*
		"depotId":6,	*#Internal id of the depot the time of use (electricity tariff) optimisation refers to*
		"operation":"Update",	*#records the creation, update or deletion of a profile*
		"timestamp":"01/19/2022 14:09:39 +00:00",	*#Timestamp of the operation*
		"startDate":"01/17/2022 00:00:00 +00:00",	*#Date when the time of use optimisation will start being applied*
		"endDate":"01/19/2022 00:00:00 +00:00",	*#Date when the time of use optimisation will stop being applied*
		"startTime":"19:00:00",	*#Time when the time of use optimisation will start being applied*
		"endTime":"23:59:00",	*#Time when the time of use optimisation will stop being applied*
		"daysOfWeek":["Monday","Tuesday","Wednesday","Thursday","Friday"],	*#Weekdays when the time of use optimisation will be applied*
		"reduction":25 }	*#Percent charge reduction during the defined period*
		The example configuration above applies a 25% reduction to the charging rate of EVs in Depot 6, from 17 January 2022 to 19 January 2022 between 19:00 and 23:59 on weekdays. It can be determined by observing the operation field, that this is an update to a time of use tariff reduction that was previously created.	

3.5.3 Flexibility events configuration

Flexibility events are set up within the system to generate bids to the DNO and instruct the system to accept and action flexibility dispatch requests and schedules from the DNO. There are two flexibility product types in the Royal Mail trial, A and B. Product A is a month ahead product which covers multiple days and is dispatched in near real-time as required by the DNO. Product B is a day ahead product where a schedule for a whole day is offered to the DNO and, if accepted is then implemented by the system. Table 25 explains the fields in the planned flexibility events table.

Table 25 – planned_flexibility_events data table

Column	Data type	Description	
offset	bigint	The order in which the record was created	
timestamp	bigint	Timestamp in Unix format in milliseconds	
key	string	Identifies uniquely a planned flexibility event	
message	string	**Example:**	
		{ "flexibilityId":621,	*#Internal flexibility plan ID*
		"type":"Product A",	*#Flexibility product type*
		"depotId":7,	*#Internal ID of the depot the flexibility event applies to (refer to* Table 10*)*
		"date":"02/07/2022 00:00:00 Z",	*#Date the flexibility event is due to happen*
		"flexibilityEvents":	*#Array of flexibility events that are part of the flexibility plan (flexibility events are individual instances of flex provision, e.g. a 24-hour flexibility plan comprises 48 flexibility events)*
		[{"flexibilityEventId":6778,	*#Internal flexibility event ID*
		"startTime":"18:00:00",	*#Time the flexibility event is due to start*
		"endTime":"20:00:00",	*#Time the flexibility event is due to finish*
		"baselineKW":25,	*#The calculated baseline for EV charging at the depot, based on historical information*
		"maxEVHeadroomKW":17,	*#The agreed cap on EV charging during the flexibility event*
		"flexibilityTurnDownKW":8,	*#The agreed turndown on EV charging during the flexibility event*
		"runTime":120, }],	*#The agreed turndown runtime on EV charging during the flexibility event in minutes. The event will end after this run time if the end time hasn't been reached and a stop command hasn't been received.*
		"operation":"Update",	*#records the creation, update or deletion of a profile*
		"timestamp":"02/02/2022 09:26:46 +00:00"}	*#Timestamp of the operation*

3.5.4 Flexibility dispatches

Once a flexibility event has been created the DNO can request that an event is actioned through a dispatch request API message. The flexibility_dispatches table details the dispatches received for the Royal Mail sites. Dispatch messages vary for products A and B:

- In product A, dispatches are sent shortly before flexibility is required. A specific turn down is requested. Further messages can be sent to alter or end flexibility provision (an end message being a request for 0kVA.
- In product B, a single schedule covering a full day (48 half-hour periods) is sent at the end of the previous day. A specific load is requested for each period.

Table 26 – flexibility_dispatches data table

Column	Data type	Description	
offset	bigint	The order in which the records were created	
timestamp	bigint	Timestamp in Unix format in milliseconds	
key	string	Identifies uniquely each flexibility dispatch	
message	string	**Example Product A**. Each message will either contain a Product A or Product B dispatch	
		{ "dispatches": [{ "depot_id": 7,	#Internal id of the depot the flexibility event applies to
		"flexibility_unit_uuid": "07bc7afa-d385-4520-9c44-b269657ee7e0",	#Unique ID assigned to each flexibility unit
		"dispatch_start_timestamp": "2022-06-08T17:00:00.025+00:00",	#The time from which the instructed power value is valid – Inclusive
		"dispatch_end_timestamp": "0001-01-01T00:00:00+00:00",	#Default timestamp, since there's no end timestamp in Product A dispatches
		"dispatch_power_kw": 27.9,	#The delta between baseline and expected operating point. Zero dispatch_power_kw represents a stop instruction, which means the flexibility event is over
		"created_by": "system", "created_timestamp": "2022-06-08T16:45:04.1093187+00:00", "product_type": "A" }]}	#Details of when the dispatch was created and the flexibility product
message	string	**Example Product B**	
		{ "dispatches": [{	#Internal id of the depot the flexibility event applies to

Column	Data type	Description	
		"depot_id": 2,	
		"flexibility_unit_uuid": "970cd0cb-4d2a-43af-aaf0-956138012263",	#Unique ID assigned to each flexibility unit
		"dispatch_start_timestamp": "2022-03-08T00:00:00+00:00",	#Start time of the market period - Inclusive
		"dispatch_end_timestamp": "2022-03-08T00:30:00+00:00",	#End time of the market period - Exclusive.
		"dispatch_power_kw": 22.0,	#The setpoint which the Flexibility Unit is expected to operate at
		"created_by": "system", "created_timestamp": "2022-03-07T15:34:20.4722608+00:00", "product_type": "B" },	#Details of when the dispatch was created and the flexibility product
		{ "depot_id": 2, "flexibility_unit_uuid": "970cd0cb-4d2a-43af-aaf0-956138012263", "dispatch_start_timestamp": "2022-03-08T23:30:00+00:00", "dispatch_end_timestamp": "2022-03-09T00:00:00+00:00", "dispatch_power_kw": 12.0, "created_by": "system", "created_timestamp": "2022-03-07T15:34:20.9544784+00:00", "product_type": "B" }]}	#Each Product B dispatch contains a 24h period broken into 48 30min periods, starting at 00:00 of a certain day, and ending at 00:00 of the following day. This example represents the start and end periods. Intermediate periods follow the same format

3.6 Depot trial summary datasets

Comprehensive summary of the Royal Mail datasets was created to provide an outline of the flexibility and profiled connection trials, encompassing data related to EVs, depot loads, charging points, location, time, and event information. Table 27 to Table 32 list the fields stored in these datasets.

Table 27 – depot load data table

Column	Data type	Description
depot_id	integer	Unique identifier for the depot.
ev_load	integer	Amount of electric vehicle load in kW.
ev_load_timestamp	Timestamp without time zone	Timestamp when the electric vehicle load was recorded.
capacity_kva	integer	Agreed supply capacity of the depot in kVA.
final_headroom	integer	Amount of remaining capacity in kVA after accounting for the electric vehicle load.

Table 28 – EV details by site data table

Column	Data type	Description
depot_name	character varying	The name of the depot where the vehicles are located
model	character varying	The make and model of the vehicle
vehicles	integer	The number of vehicles of a specific make and model available at the depot
charge_rate_kw	integer	The AC charge rate of the vehicle battery in kilowatts

Table 29 – CP count data table

Column	Data type	Description
Site	character varying	The name of the charging site.
Alfen Twin	Integer	The number of Alfen twin socket chargers available at the site.
Alfen Single	Integer	The number of Alfen single socket chargers available at the site.
Swarco Twin	Integer	The number of Swarco twin socket chargers available at the site.

Table 30 – enacted flexibility product A data table

Column	Data type	Description
depot_id	integer	A unique identifier of the depot where the product is stored.
product_type	character varying	The type or name of the product.
start_time	timestamp with time zone	The starting time of the product run in the specified time zone.
run_time	integer	The duration of the product run in minutes.
baseline_kw	integer	The baseline power consumption of the product run in kilowatts.
flexibility_turndown_kw	integer	The amount of power flexibility achieved during the product run in kilowatts.

Table 31 – enacted flexibility product B data table

Column	Data type	Description
depot_id	integer	A unique identifier of the depot or facility.
product_type	character varying	The type of product.
start_time	timestamp with time zone	The starting time of the interval.
end_time	timestamp with time zone	The ending time of the interval.
baseline_kw	integer	The expected energy usage at the start of the interval.
flexibility_turndown_kw	integer	The amount of energy reduced in case of a demand response event.
max_ev_headroom_kw	integer	The amount of energy used to charge electric vehicles during the interval.
final_turndown_kw	integer	The amount of energy reduced after the flexibility turn-down has been applied.
final_ev_headroom_kw	integer	The amount of energy that can be used to charge electric vehicles after the max EV headroom has been applied.

Table 32 – load profile data table

Column	Data type	Description
depot_name	string	The name of the charging depot.
timestamp	datetime	The timestamp of the hour for which the data pertains.
unmanaged_charging	integer	A binary variable indicating whether unmanaged charging is occurring at the timestamp (1 if it is, 0 otherwise)
smart_charging	integer	A binary variable indicating whether peak shaving smart charging is occurring at the timestamp
tou_tariff	integer	A binary variable indicating whether time-of-use smart charging is occurring at the timestamp
profiled_connection	integer	A binary variable indicating whether unmanaged charging is occurring at the timestamp
flex_a	integer	A binary variable indicating where flexibility product A (month-ahead) is occurring at the timestamp
flex_b	integer	A binary variable indicating where flexibility product B (day-ahead) is occurring at the timestamp
flex_multi_event	integer	A binary variable indicating where multiple flexibility events are occurring at the timestamp
flex_run_time	integer	The duration of the current flexibility event in hours
flex_start_time	Timestamp without timezone	The hour at which the current flexibility event starts at
flex_success	integer	A binary variable indicating whether the current flexible charging event was successful or not.

Column	Data type	Description
flex_availability_kwh	float	The available charging capacity, in kWh, offered for the flexibility event
flex_utilization_kwh	float	The charging capacity turned down, in kWh, for the current flexibility event.
flex_turndown_ratio	float	The percentage of available charging capacity that was utilized for the current flexible charging event. i.e. the turndown achieved with respect to what was offered
flex_breach_rate	float	The percentage of time that the agreed load profile was breached during the event
ev_load_kw	float	The average load, in kW, during the current hour.
min_ev_load_kw	float	The minimum load, in kW, during the current hour.
max_ev_load_kw	float	The maximum load, in kW, during the current hour.
tariff_norm	float	The normalized tariff value for the current hour.

4 WS3 Data (Mixed trial)

WS3 made use of data collected through the Uber platform, detailing the start and end time of all trips made by EVs on the platform in Greater London, together with the location at the start and end of each trip. As this data is commercially sensitive to Uber, and could reveal the locations of drivers and customers, the project is only able to release data and findings at a high level for WS3. Further analysis of the data will follow in Deliverable D7.

The Uber dataset provides an overview of the potential impact on the ability of the distribution network to support growing demand from PHVs at different times of day in each London borough. To do this, the load expected to have been caused by charging of Uber PHVs at each time and location is deducted from the available headroom at nearby distribution substations. A red-amber-green (RAG) scale is used to highlight when and where there are likely to be a requirement for network upgrades as a result of PHV electrification. Table 33 explains the structure of this data, Table 34 explains the meaning of the RAG colours and Table 35 details the time windows in the data.

Table 33 – WS3 Network impact by borough

Column	Description
borough_id	A number representing the London borough the entry refers to
borough_name	The full name of the London borough the entry refers to
time_window	The time window for this status (see Table 35 for key to time windows)
borough_avg_RAG_status	Red, amber or green status based on available capacity after load from Uber EVs is deducted. This status is based on the capacity of the secondary substation with the most capacity in each Lower Layer Super Output Area (LSOA), averaged across all LSOAs in the borough. A key to the RAG status can be found in Table 34.
pct_lsoas RED	The percentage of LSOAs in the borough where substation capacity is in the RED category
pct_lsoas AMBER	The percentage of LSOAs in the borough where substation capacity is in the AMBER category
pct_lsoas GREEN	The percentage of LSOAs in the borough where substation capacity is in the GREEN category

Table 34 – Explanation of RAG scale

Colour	Description
RED	<=200kVA capacity available on the secondary substation with the most available capacity in the LSOA, following the deduction of Uber demand
AMBER	>200kVA and <600kVA capacity available on the secondary substation with the most available capacity in the LSOA, following the deduction of Uber demand
GREEN	>=600kVA capacity available on the secondary substation with the most available capacity in the LSOA, following the deduction of Uber demand

The time periods are broken down into five periods as shown in Table 35.

Table 35 – Time periods in WS3 data

Timing
00:00 – 05:00
05:00 – 10:00
10:00 – 16:00
16:00 – 20:00
20:00 – 00:00

5 Accessing the Optimise Prime Datasets

The Optimise Prime datasets can be accessed on UK Power Networks' Open Data Portal at the following link:
https://ukpowernetworks.opendatasoft.com/explore/dataset/optimise-prime/information/

Figure 3 shows a view of the Optimise Prime page on UK Power Networks' Open Data Portal. The Information tab describes the content of the datasets, and includes a table with required information to access the repository where the dataset is hosted.

Figure 3 – Open Data Portal - Optimise Prime page

Certain tables, such as vehicle telematics messages and charge point measurements, are very large in size, with some tables of data including tens of millions of rows. While the data has been broken down into daily and monthly files where practical, many files may still be too large to open or analyse in spreadsheets by software such as Microsoft Excel. Opening files in such a way and then saving may also result in changes to the content of the files. It is recommended that the user either:

- Connects to the dataset repository, to query or visualise through a program such as Microsoft Power BI or Jupyter Notebook in order to manage the volume of data. This process is explained in section 5.1; or
- Downloads the dataset locally (process explained in Section 5.2) and then utilise data analytics software to process them.

All required information to access the datasets are available on the Open Data Portal in a table at the bottom of the information tab, as shown in Figure 4. Please note that the content of this table is subject to periodical update in accordance with UK Power Networks' Information Systems policies, therefore it is left blank in this document.

Figure 4 – Information required to access the datasets on the Open Data Portal (left blank here as subject to change)

To access the datasets, use the below Account name and Shared Access Signature (SAS) token:

Account Name or URL	
Shared Access Signature (SAS)	
Shared Access Signature URL (SAS)	

5.1 Accessing the datasets via Microsoft Power BI

Using the option to Get Data from Azure Blob Storage in Power BI will allow the user to connect to the shared storage. Example on how to load the data files into Power BI is illustrated in Figure 5,

Figure 5 – Power BI Get Data window to access shared storage

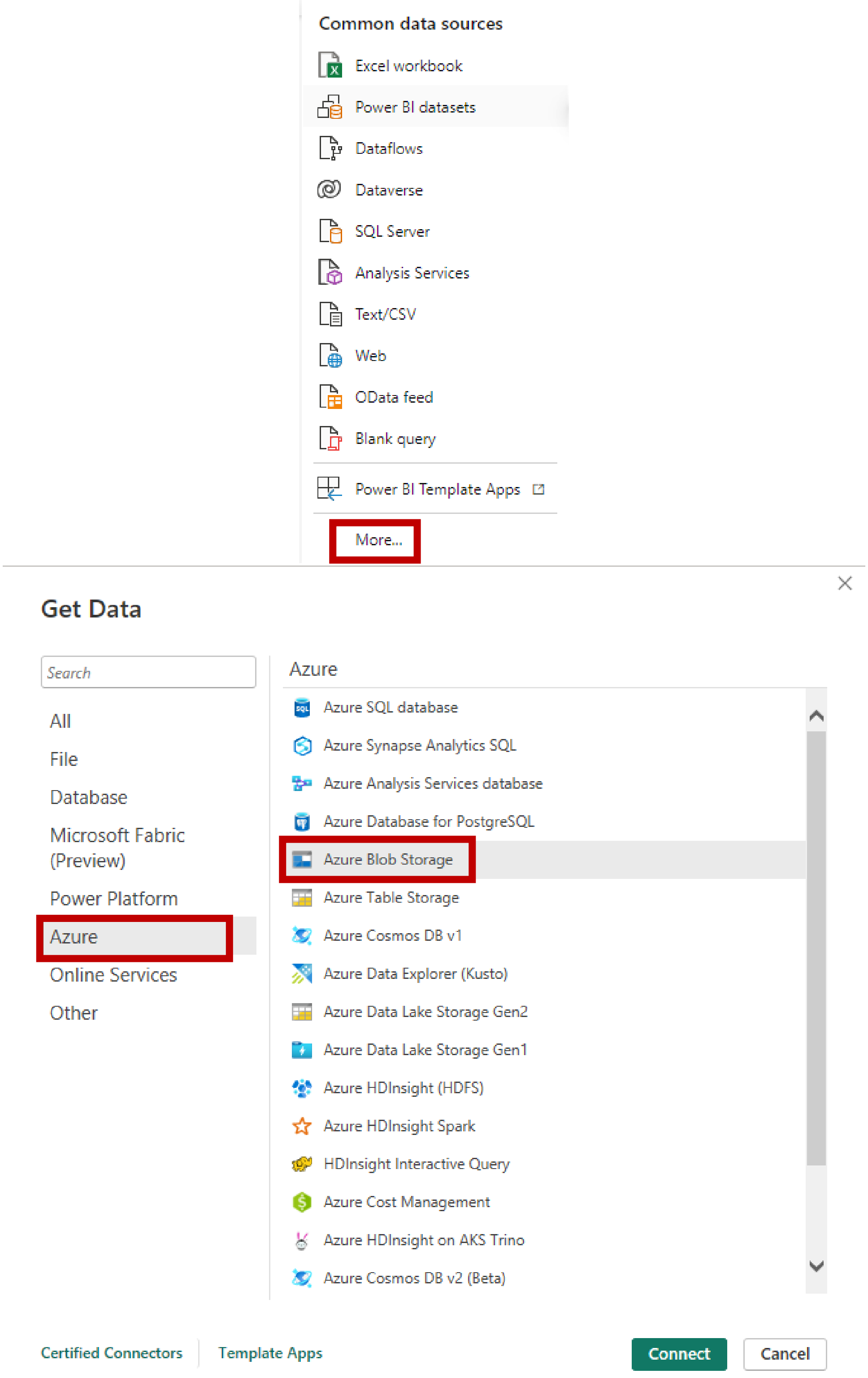
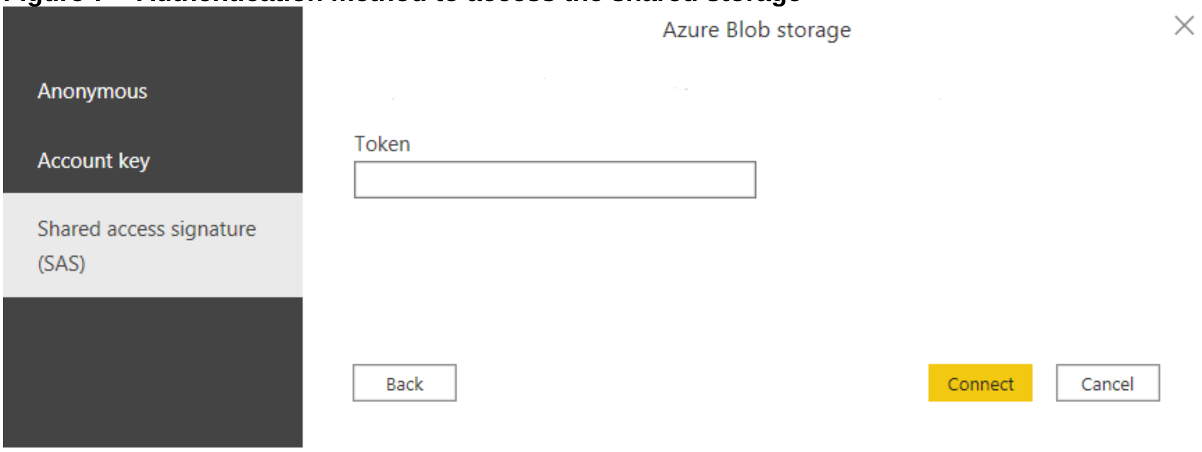


Figure 6: Power BI - Blob Storage window to access shared storage

The user should use the Account name/URL available on the Open Data Portal (Figure 4) in the above field and click “OK”.

A window prompting authentication to the Azure Blob Storage will appear. The user should choose: Shared Access Signature (SAS).

Figure 7 – Authentication method to access the shared storage



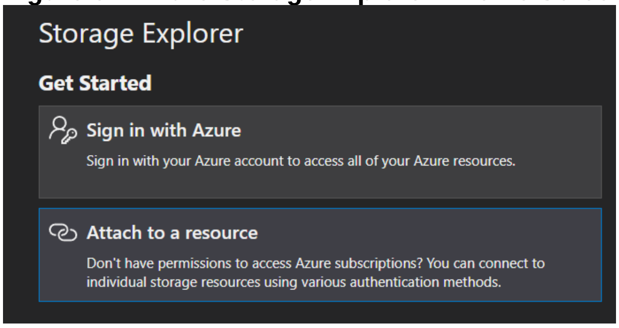
The Shared Access Signature (SAS) requested in Figure 7 is available on the Open Data Portal (Figure 4).

5.2 Downloading the Optimise Prime datasets

Should the user require to download the files and store them locally, the software Azure Storage Explorer can be used. The below hyperlink can be used to download it.
Azure Storage Explorer | Microsoft Azure

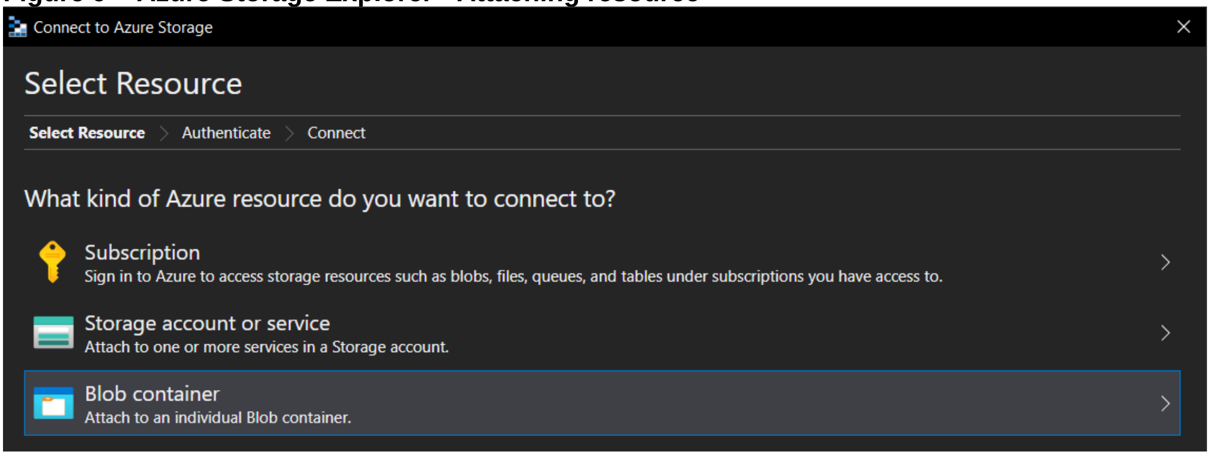
Once installed, "Attach to a resource" option should be selected by the user, as shown in Figure 8.

Figure 8 – Azure Storage Explorer - Home Screen



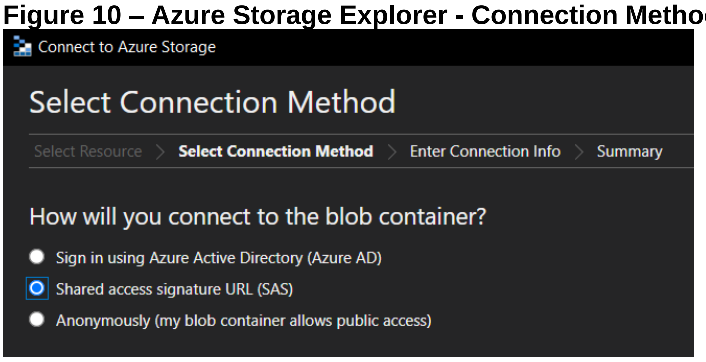
The user should then select the "Blob container" option as shown in Figure 9.

Figure 9 – Azure Storage Explorer - Attaching resource



The connection method should be set as Shared Access Signature URL (SAS), as shown in Figure 10.

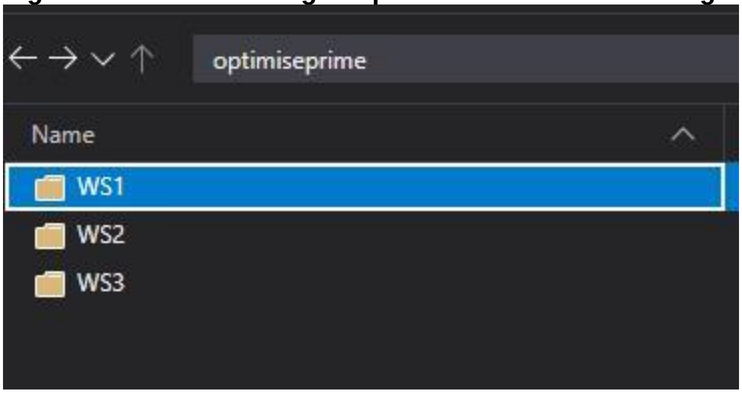
Figure 10 – Azure Storage Explorer - Connection Method



The Shared Access Signature URL (SAS) link is available on the Open Data Portal (refer to Figure 4).

Once connected, the user will be able to navigate and download all the dataset files in each folder as shown in Figure 11.

Figure 11 – Azure Storage Explorer – Folders containing the datasets



For further support to access the datasets, please contact opendata@ukpowernetworks.co.uk.

6 Table of Figures

7 List of Tables