Transport

Energy Infrastructure

Knowledge & Enterprise

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Webinar: Introduction to Electric Waste Fleet Charging Infrastructure and Strategy

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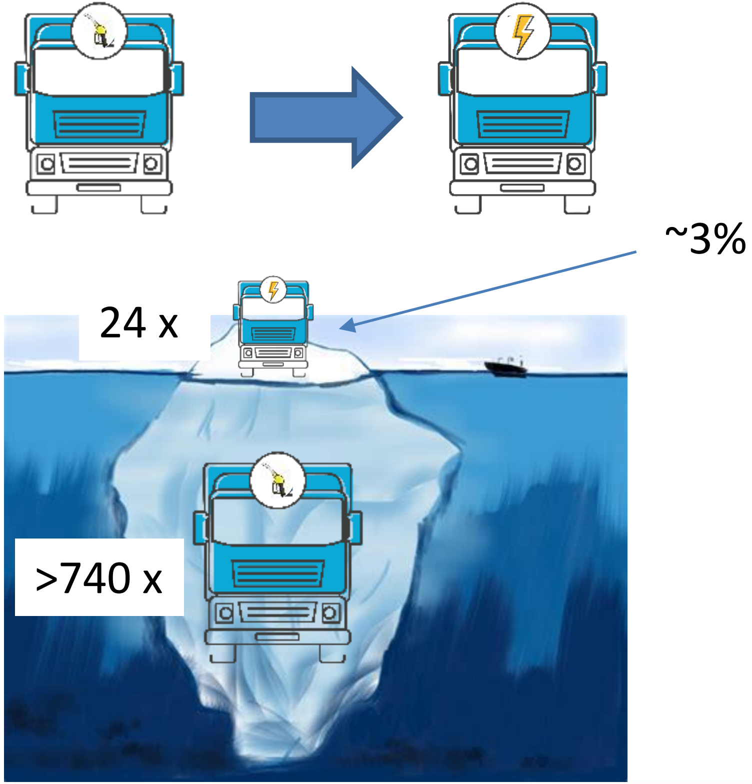
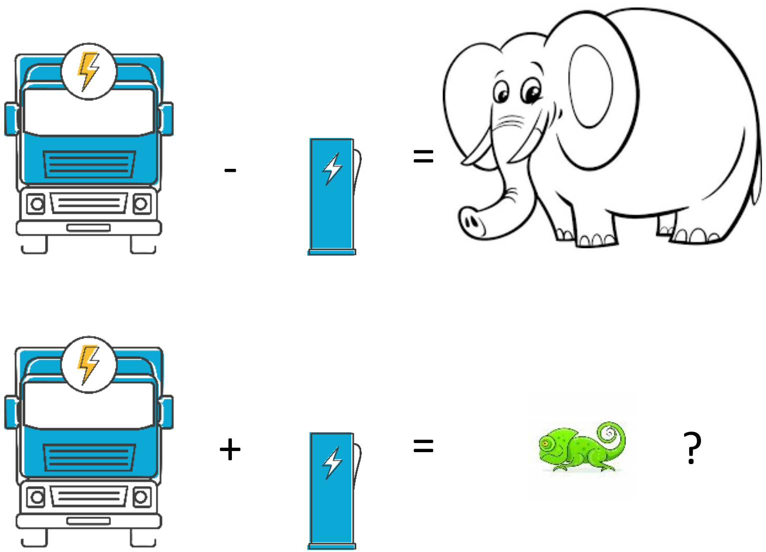
Why are we here today?

Local Authority	Vehicle Type	Make & Model	Number of Vehicles Deployed	Number of Vehicles Expected	Dates Expected
Cardiff	RCV	Dennis Eagle eCollect	1	6	March – June 2022
Carmarthenshire	RCV	Electra	0	3	September 2022
Conwy	RRV	Romaquip	1	6	June 2022
Denbighshire	RCV	Dennis Eagle eCollect	0	2	July 2022
Flintshire	RRV	Terberg	0	2	March 2022
Gwynedd	RRV	Romaquip	0	2	June 2022
Newport	RCV	Dennis Eagle eCollect	4	0	-
Powys	RCV	Dennis Eagle eCollect	1	0	-
Swansea	RCV	Dennis Eagle eCollect	1	0	-
Torfaen	RCV	Dennis Eagle eCollect	0	2	June 2022
Wrexham	RCV	EMOSS e-One	0	1	June 2022
		Totals	8	24	



Why do we need charging infrastructure?

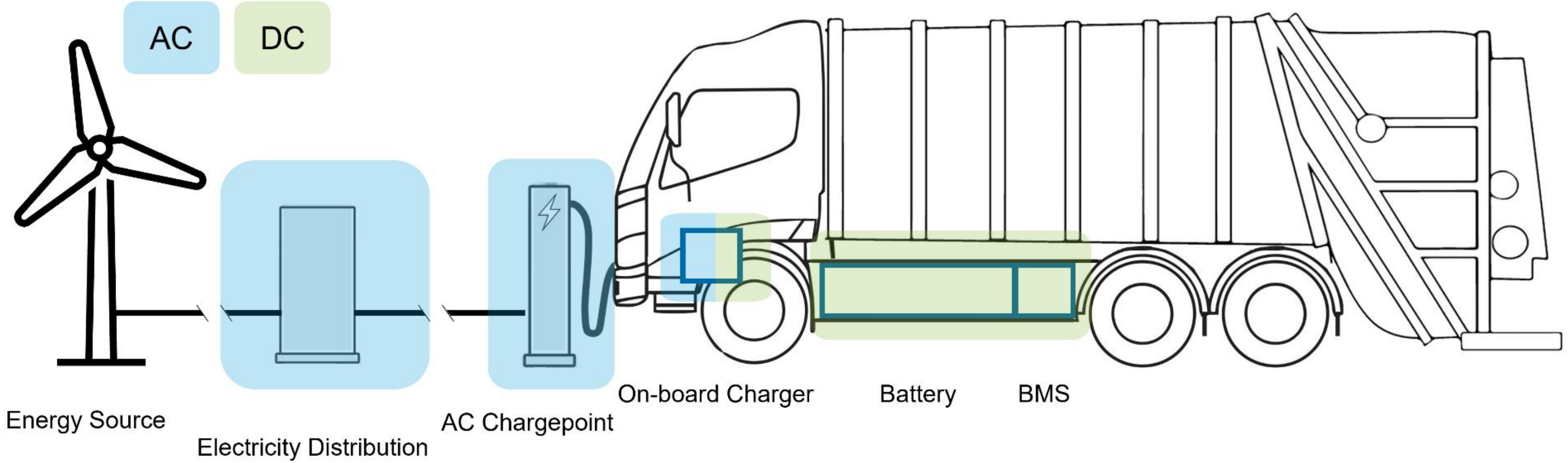


	Dennis Eagle eCollect	Electra	EMOSS e-One	Romaquip	Terberg
Image					
Chassis Config	6x2	6x2	6x2	4x2	4x2
GVW (tonnes)	27	27	26	Dec-14	12
Motor size (kW)	200	380	No data	No data	No data
Battery size (kWh)	300	285 – 350	130 – 285	180	No data
DC Charging Power / kW	40	None	150	100	None
DC Connector	CCS	N/A	CCS	CCS	N/A
AC Charging Power / kW	None	22 (44[1])	22 (44[1])	22	No data
AC Connector	N/A	Type 2	Type 2	Type 2	Type 2

[1]The eMoss e-One and Electra specify 44 kW AC charging, but unclear whether this is via Type 2 charging or Commando connectors (IEC 60309)
Use of Commando connectors is not recommended for a permanent EV charging solution.

AC vs DC Charging

AC Charging

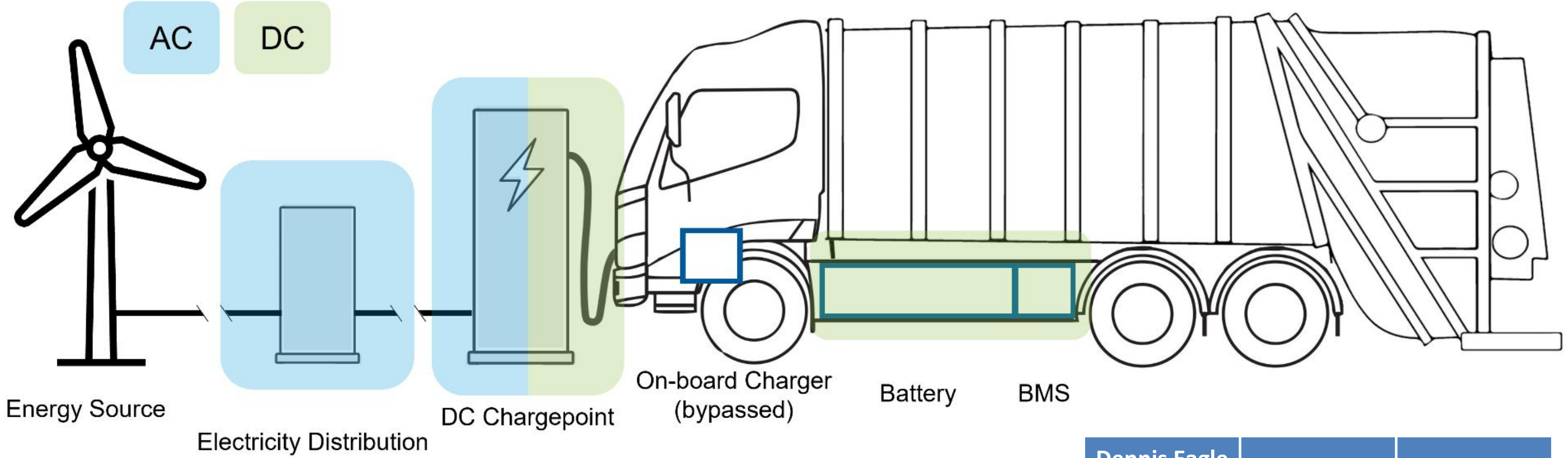


- Rectification from AC to DC happens on the vehicle using the "on-board charger"
- Used for lower power charging (≤ 22 kW) where dwell times are longer.

Electra	EMOSS e-One	Romaquip	Terberg

AC vs DC Charging

DC Charging

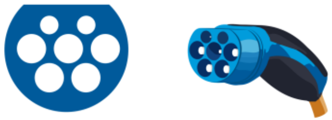
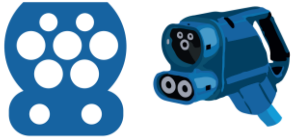


Dennis Eagle eCollect	EMOSS e-One	Romaquip

- Rectification from AC to DC is done by the chargepoint.
- For cars and vans, used for higher power charging where time is limited. However for eRCVs/eRRVs with very large batteries (200+ kWhs), DC may even be needed for long dwell time charging.

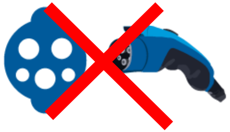
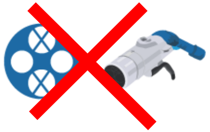
Chargepoint Connector Standards

The two connector standards being used by electric waste fleet vehicles:

AC, Mode 3	Type 2	 IEC 62196-2		  Socket outlet or tethered
DC, Mode 4	CCS	 IEC 62196-3		 Tethered only

What about commando, CHAdeMO and Type 1?

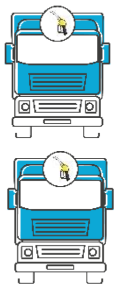
- Some of the current eRCV/eRRV models do include AC charging via commando. However, this is not recommended for a permanent EV charging infrastructure system.
- Luckily none make use of CHAdeMO or Type 1

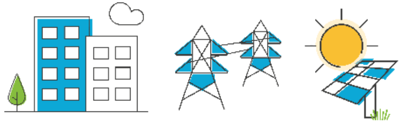
Key takeaway 1: Ensure your infrastructure is AC/DC and Type 2 or CCS to suit vehicles you are deploying.

Devising a Fleet Charging Strategy

Inputs



Vehicles:
- Number of vehicles
- Vehicle speeds
- Number of bin lifts
- Compaction cycles
- Payload
- Ambient temperatures
- Driving style
- Topography
- Shift start and end times
- Number of shifts

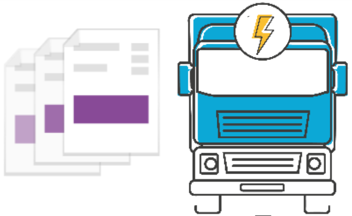


Depot:
- Maximum Import Capacity
- Existing electrical demand
- Existing electrical infrastructure
- Parking locations

Analysis

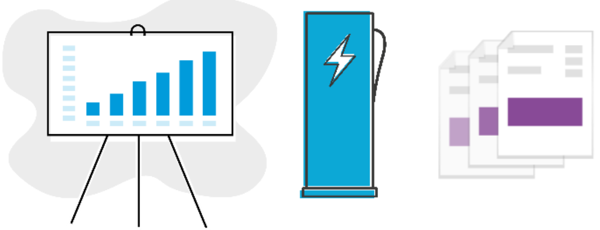
To churn the numbers, there are various methods to use, in order of the amount of resource required:
- Copy
- Convert
- Trial
- Calculate

Outputs



Vehicle Specification

Charging Infrastructure Strategy and Specification



For a fleet that only charges at the depot the exam questions for the charging strategy are essentially:

1. How many kWhs do I need to recharge each day?
2. How many hours are available in which to do it?

Understanding Charging Power Limitations

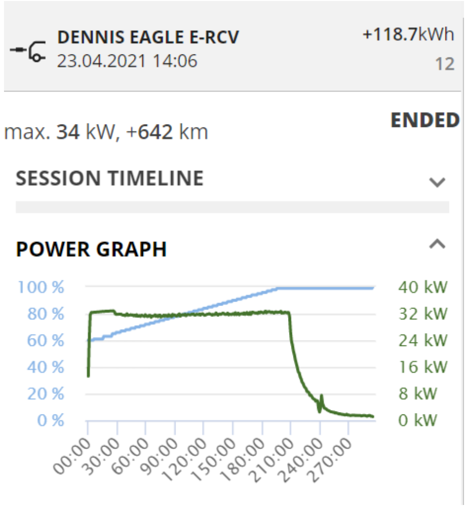
1. The charging power is limited by one of the vehicle or the chargepoint:

	Standard 7 kW AC (32 A single-phase)	Fast 22 kW AC (32 A three-phase)	Rapid 50 kW DC	Ultra-Rapid 350 kW DC
TERBERG KERBLOADER / ELECTRA — AC CHARGING: 22 KW[5] DC CHARGING: N/A	7 kW	22 kW	N/A	N/A
DENNIS EAGLE ECOLLECT — AC CHARGING: N/A DC CHARGING: 40 KW	N/A	N/A	40 kW	40 kW
ROMAQUIP — AC CHARGING: 22 KW DC CHARGING: 100 KW	7 kW	22 kW	50 kW	100 kW
RVS EMOSS E-ONE — AC CHARGING: 22 KW[5] DC CHARGING: 150 KW	7 kW	22 kW	50 kW	150 kW

2. This is the maximum rated charging power, not the power you will get throughout the charge. As shown in the example charge curve below:

- Achieved maximum power can be lower depending on vehicle, chargepoint, and environmental conditions.
- Charging power may reduce as the battery reaches a high state of charge (SOC)

Example charging curve from Newport with Kempower chargepoint



Analysis (Trial) – Refuse Collection Vehicles

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- For cars and vans, as driving efficiency is fairly consistent, to calculate number of kWhs you need for a journey is simple: (kWh/mile) * miles!
- For RCVs, although more efficient than diesel equivalent, depending on usage factors shown before.
- Evidence from trials is that efficiency can vary from 4-8 kWh/mile. Longer routes more efficient.
- This equates to 14 – 24 kWh/hour.

Thinking in terms of kWh/hour operational:

Output Value: Operational time (hours)
Charging time: Maximum, 16 hours
25% safety factor applied

Charging Power (kW)	Driving efficiency (kWh/hour)					
	24	22	20	18	16	14
7	4	4	4	5	6	6
11	6	6	7	8	9	10
22	12	13	14	16	18	20
50	27	29	32	36	40	46
150	80	87	96	107	120	137
350	187	204	224	249	280	320

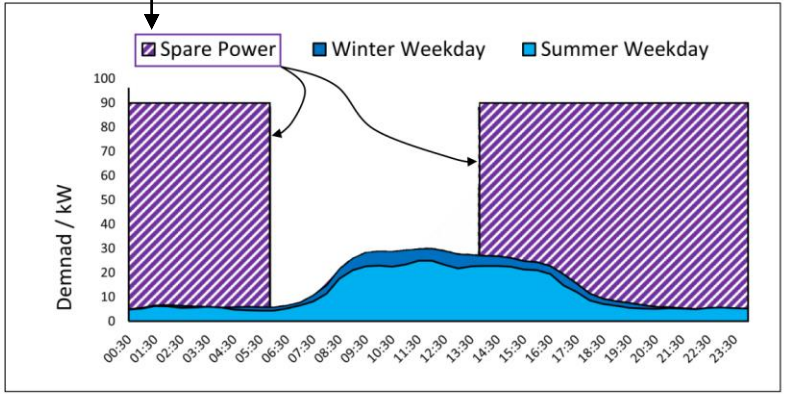
Key takeaway 2: For "base" charging, 22 kW AC is min charging specification; but 25-50 kW DC may give greater operational resilience.

Depot:
- Maximum Import Capacity
- Existing electrical demand
- Existing electrical infrastructure
- Parking locations

Step 1: Is it feasible to meet recharging requirements with current network connection?

- Think about spare energy capacity rather than spare power
- Example: 90 kW site supply
- Check 1, is there enough spare energy capacity from 14:00 – 06:00 to deliver the required charging?
- If each eRCV has a 200 kWh daily recharging requirement, then it is feasible to deliver the required recharging of 6(?) vehicles with the current grid connection.

Total = 1271 kWh

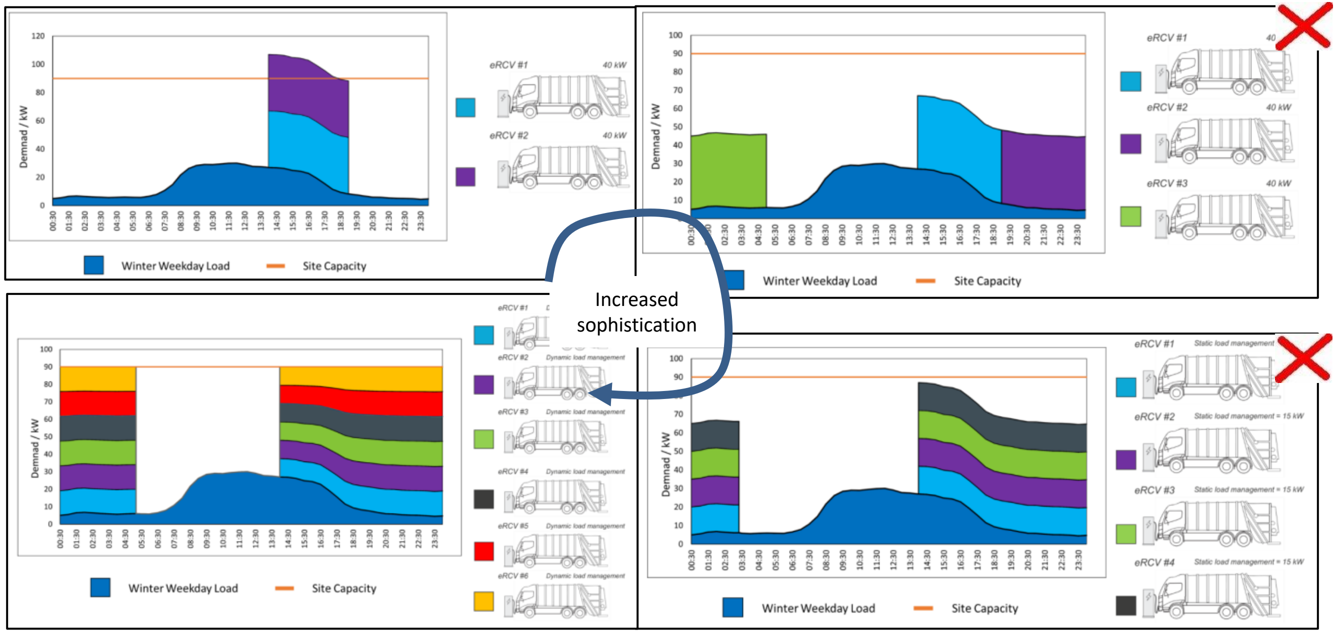


Site Assessment and Charging Strategy

Step 2: What charging strategy should I use?

1. Unmanaged – the vehicles charge at maximum power when they are plugged in.

2. Timed charging – the vehicles use any inbuilt functionality within the vehicle to control the charging time.



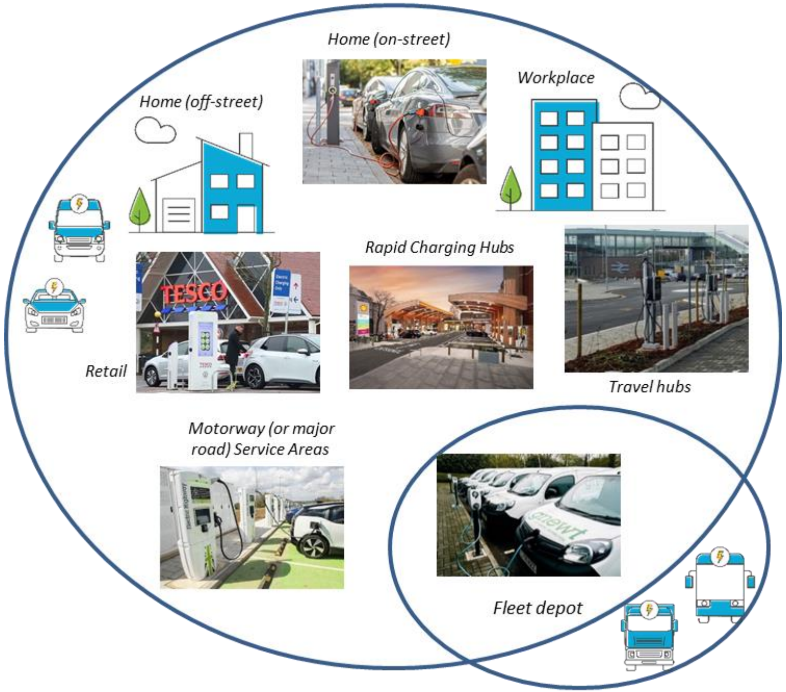
3. Static Load Management – a pre-set amount of “spare” power is shared between chargepoints.

4. Dynamic Load Management - the real-time spare power is shared between connected chargepoints.

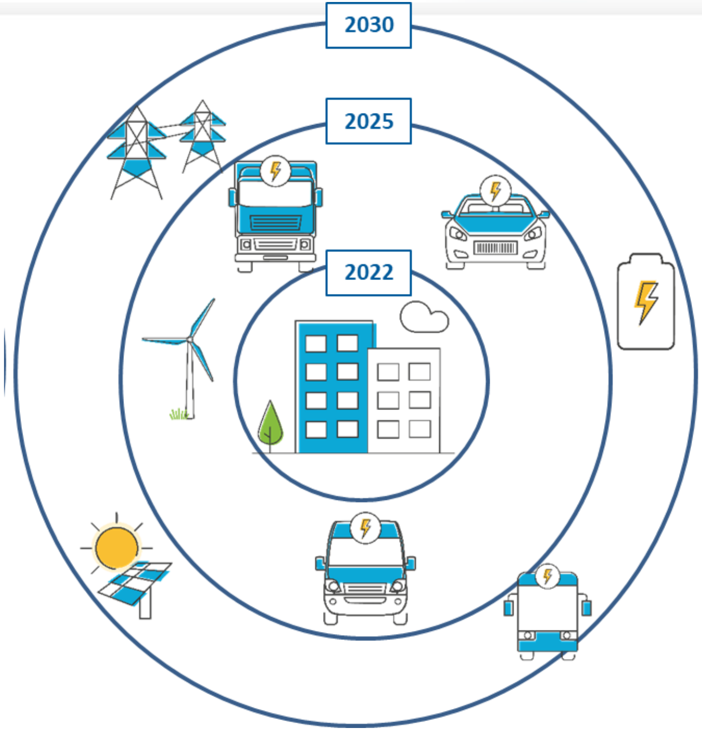
Key takeaway 3: For any site where power is likely to be a constraint, deploy a system with dynamic load management.

Key takeaway 4: Think about operational resilience. Do you need 100 kW charging as back-up?

What about other vehicle use cases?

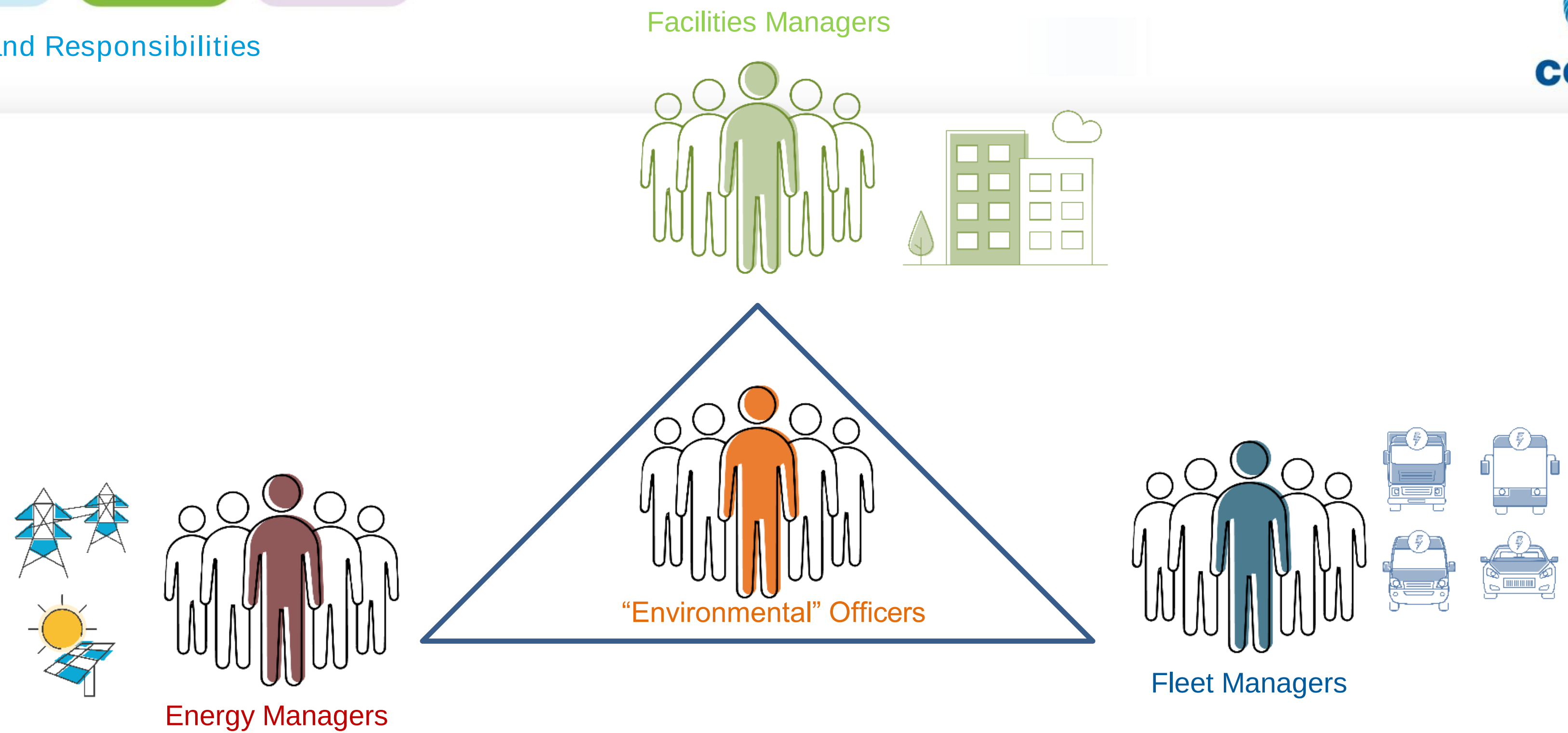


and future plans?



Key takeaway 5: Don’t think about electric waste fleet in isolation, and plan for the future

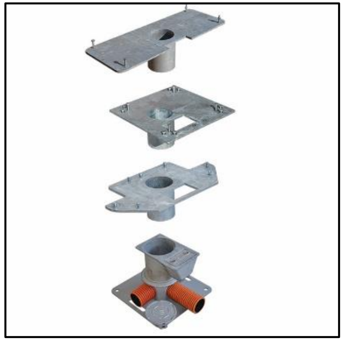
Roles and Responsibilities



Key takeaway 6: Ensure all stakeholders - including those who may not have needed to be before - are engaged.

Physical Installation Considerations

- Parking layouts (where is the vehicle charging socket?!)
- Impact protection.
- Distance from electrical distribution and any civil works required.
- Passive provision (future proofing).



Key takeaway 7: Ensure suppliers don't overlook what seem like simple installation design considerations

Summary of Key Takeaways

1. Select the appropriate chargepoint type (AC/DC and standard).
2. Select the appropriate chargepoint rated power – min. 22 kW AC or DC 25-50 kW+.
3. Use dynamic load management.
4. Think about operational resilience.
5. Plan for all vehicles and for the future.
6. Engage the necessary stakeholders.
7. Don’t underestimate the importance of simple installation design considerations.

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Thank you for listening

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Addressing the challenges of fleet electrification

Arron Dowie

ZENOBĒ

Zenobē designs, finances, builds and operates battery-based services.

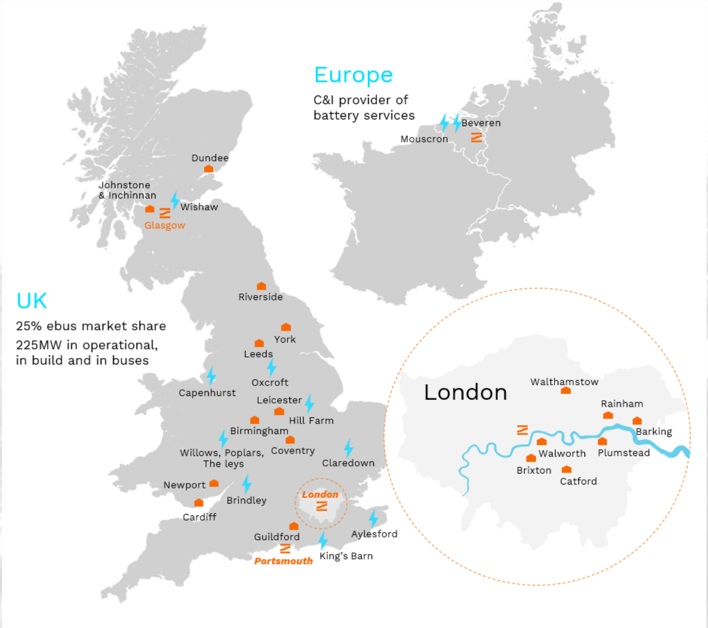
Our three main business areas:

EV
Grid
Portable power

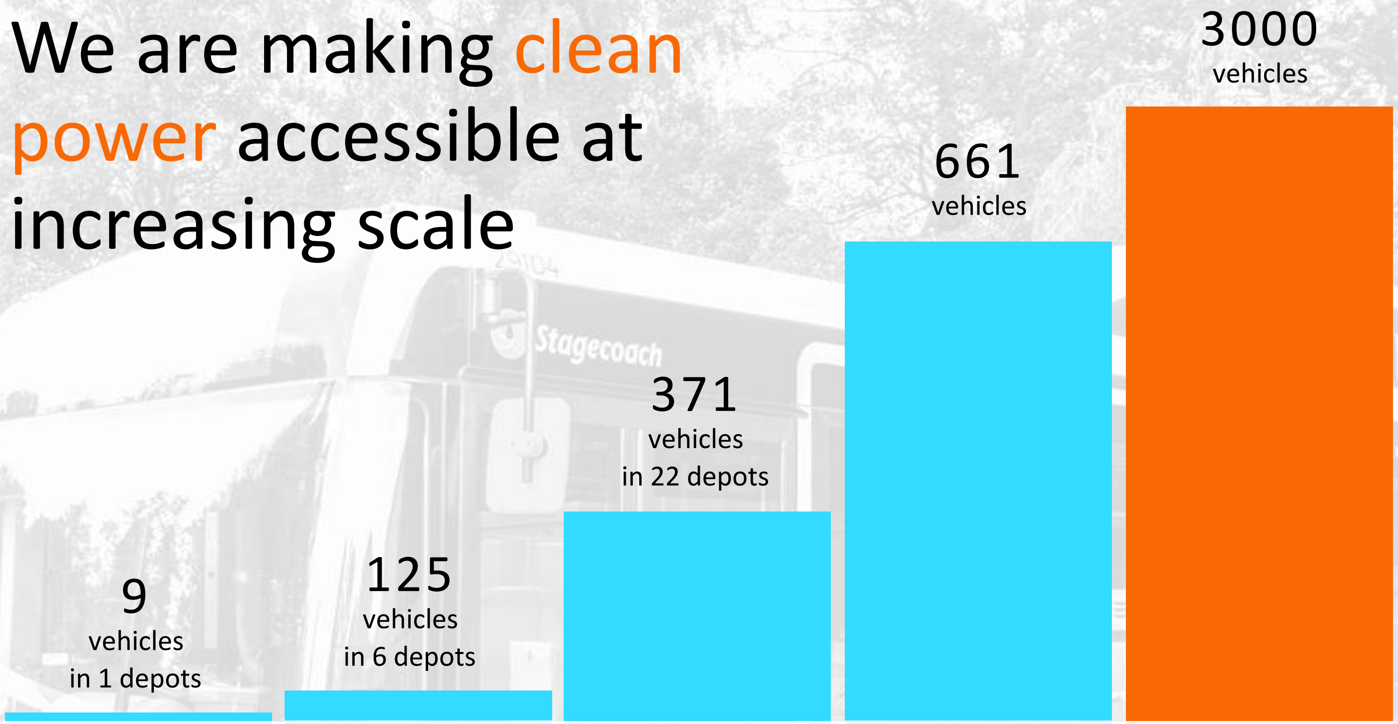
Our purpose:

Making clean power accessible

We are making clean power accessible at increasing scale



Vehicles



Capacity (MW)

2017	2018	2019	2020	2021	2022	2025
14MW	63MW	73MW	75MW	175MW	237MW	1GW

Milestones

2017
Build first battery storage facility
Tiger Infrastructure Partners

2018
First batteries to provide Fast Reserve

2019
Enter EV fleet market
Santander
Jera

2020
Win EV contracts with all UK's major bus operators
Infracapital

2021
25% UK ebus market share
Build of Europe's largest (100MW) battery
Launch of second life business

2022

2025
No 1 provider of battery services to UK fleet and grid operators

The key challenges:

High capital requirements for upfront costs and battery replacement

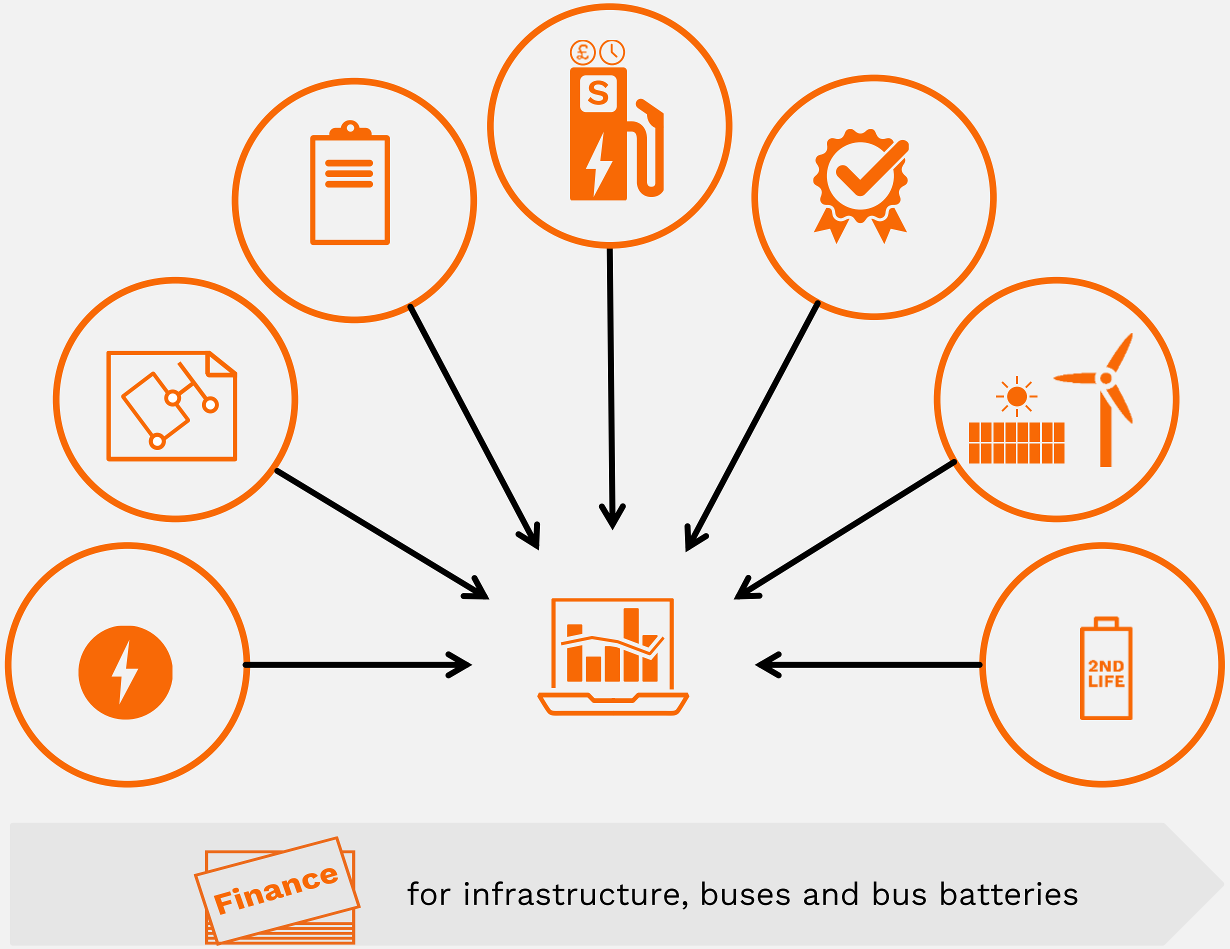
Insufficient power supply both to and within the depot to support service delivery

Unpredictable operational costs due to new technology and energy market volatility

The Zenobē service

An end-to-end fully managed service to remove these challenges

- Future proofed connection to the grid
- Bespoke design and planning to minimise upfront and ongoing costs and to meet operator requirements
- Project management of build and commissioning of infrastructure
- Smart charging to minimise energy costs
- ‘As a service’ operational guarantees and 24/7 ‘batteries as a service’ support throughout the contract
- Onsite battery storage to support smart charging and co-located power generation
- Second life applications for batteries



Case Study:
Newport Bus

The Challenge

- Depot does not have enough power to charge EVs
- Ensuring there is no operational disruption to the depot throughout the construction process
- Safety in a live bus depot environment both for depot employees and our installation team
- Space & eBus Parking Layout ensuring that no diesel vehicles are removed due to the introduction of electric vehicles
- Adapting to new operational procedures
- Ensuring that all electric vehicles are fully charged and are able to undertake their daily route

“ Zenobē are absolutely integral in our electric vision and have overcome all the challenges with us. ”

Scott Pearson MD at Newport Transport

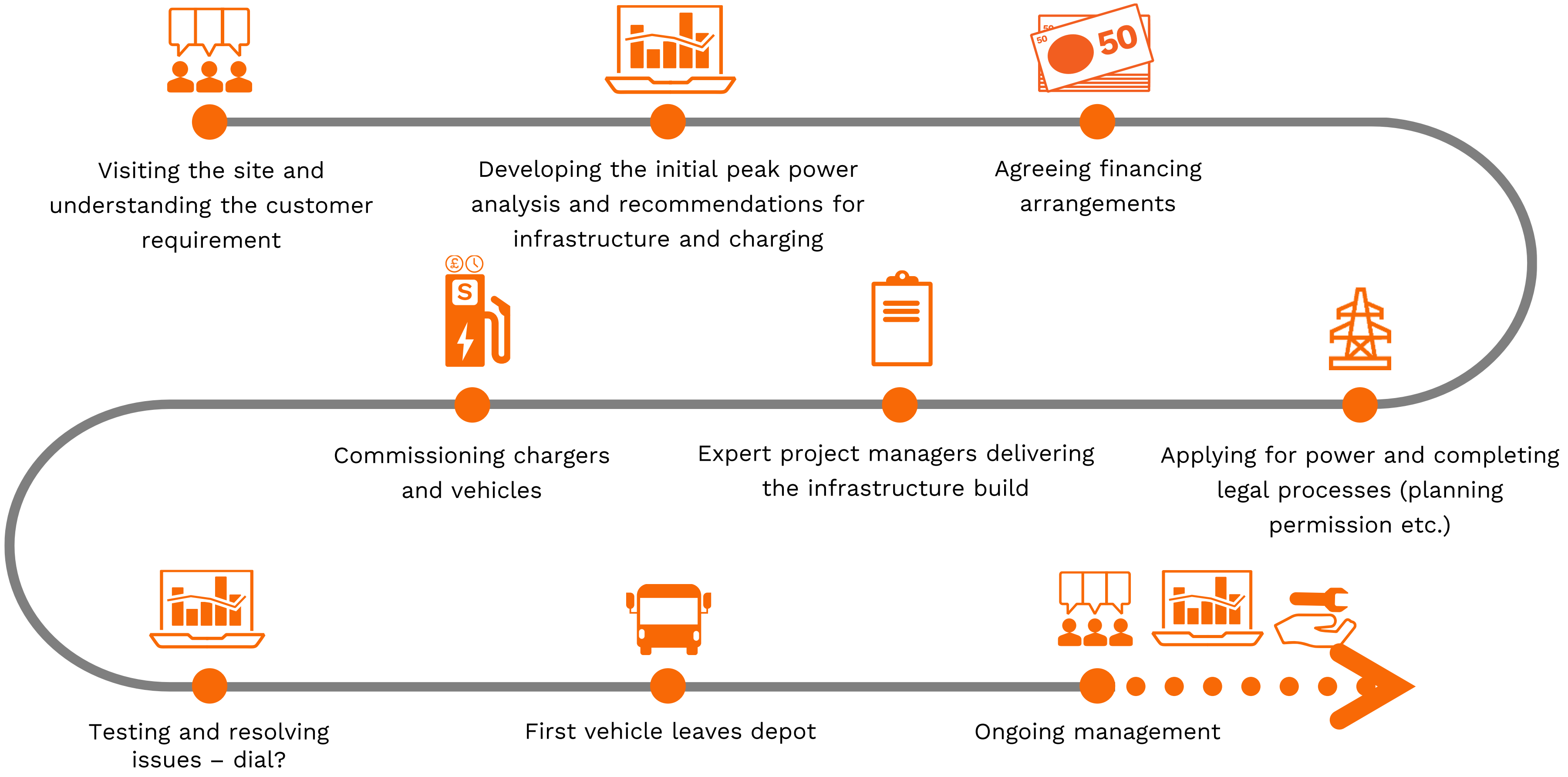
Zenobe Solution

- Devise smart charging strategy to lower substantial DNO grid upgrade costs and ongoing standing charges
- Phase 1 -Stationary battery energy storage system (BESS) is installed to support grid when charging EVs at peak periods
- Full EV operation considered when installing major electrical components
- Phase 2 – DNO upgrade to 1.8MVA after local reinforcement works complete by DNO
- We financed all infrastructure capex including DNO costs with Newport only paying a rental once operational.
- We matched financed grant monies from Welsh Assembly to maximise the number of eBuses accelerating the road to Net Zero
- Zenobe offer a charging guarantee and take all responsibility for ensuring these critical public service are maintained.

CATEGORY	REQUIREMENTS
Route	Newport to Cardiff
Bus Type	32 x Yutong Single deck
Battery Capacity	422kWh (13.5MW)
Number of Chargers	17 x 120kW DC
Authorized Supply Capacity (ASC)	Phase 1 – 0.28MVA Phase 2 – 1.8MVA

ZENOBĒ SOLUTION SUMMARY	
Innovative OPEX financing	✓
Limited ‘regret cost’ in depot expansion	✓
Smart charging strategy	✓
Parking Strategy Optimisation	✓

Planning



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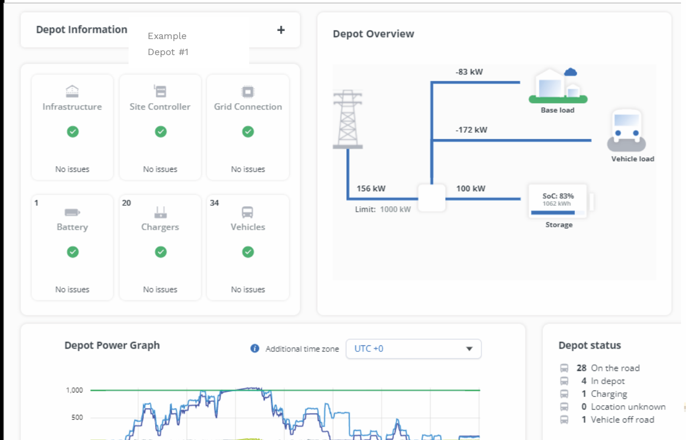
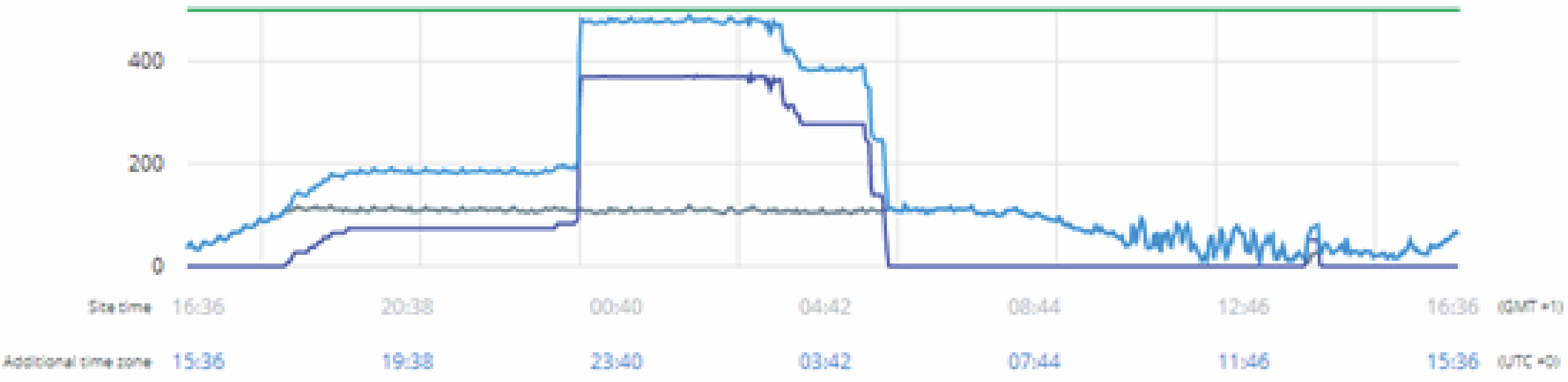
Visiting the site and understanding the customer requirement
Developing the initial peak power analysis and recommendations for infrastructure and charging
Agreeing financing arrangements
Applying for power and completing legal processes (planning permission etc.)
Expert project managers delivering the infrastructure build
Commissioning chargers and vehicles
Testing and resolving issues – dial?
First vehicle leaves depot
Ongoing management

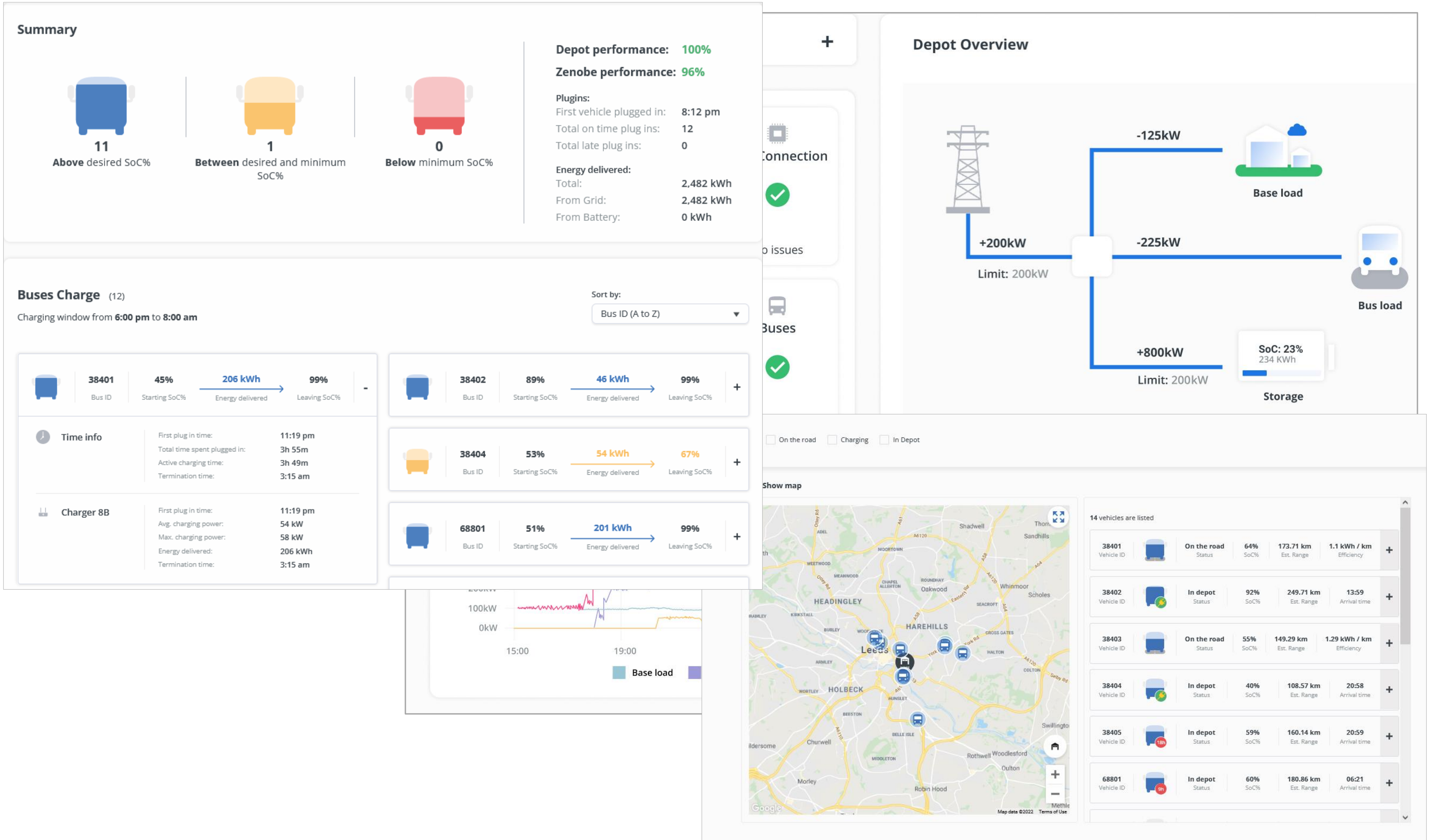
Challenge:
Minimising energy costs

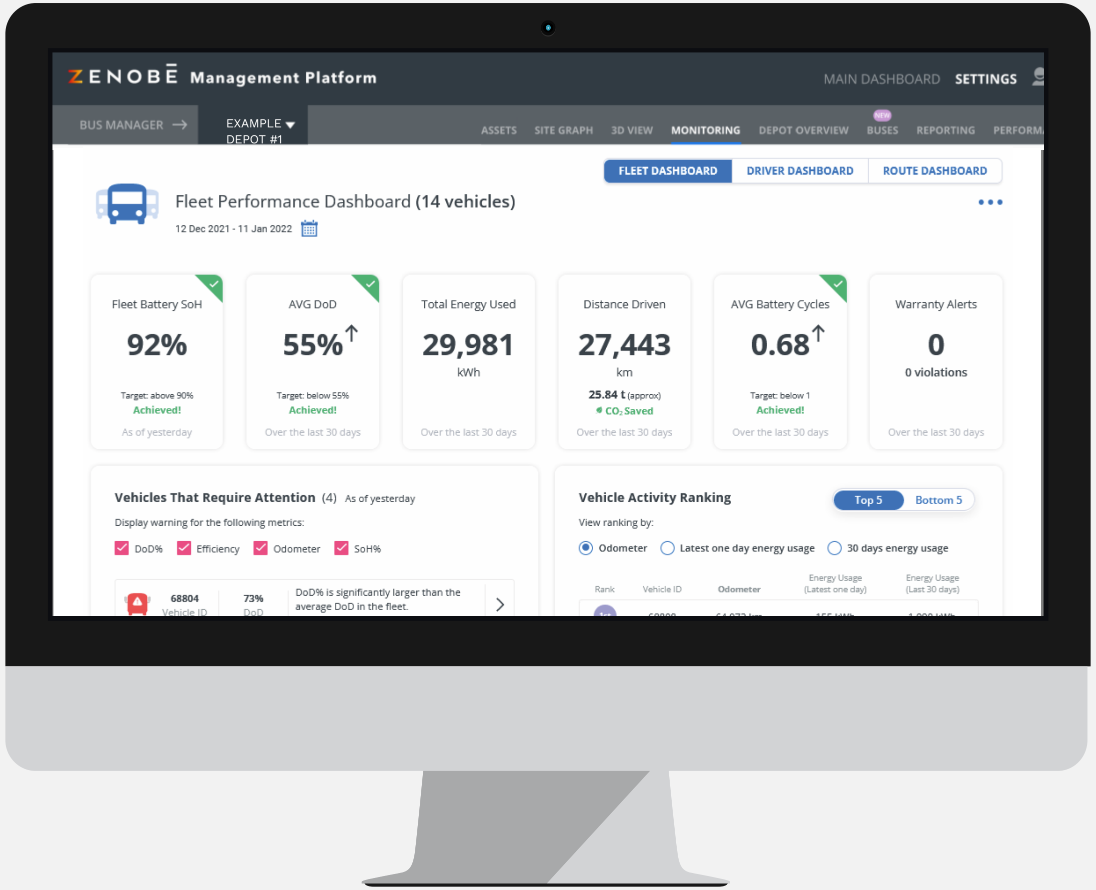
Solution:
Smart software and energy purchase strategies

- Providing award-winning software to track energy use by vehicle and by driver, so that inefficient driving can be managed and efficient driving incentivised
- Developing charging strategies bespoke to the fleet, minimising running costs and the risk of exceeding power allowances
- Arranging power purchase agreements to minimise uncertainty and use our position as grid infrastructure provider






Summary
11
Above desired SoC%
1
Between desired and minimum SoC%
0
Below minimum SoC%
Depot performance: 100%
Zenobe performance: 96%
Plugins:
First vehicle plugged in: 8:12 pm
Total on time plug ins: 12
Total late plug ins: 0
Energy delivered:
Total: 2,482 kWh
From Grid: 2,482 kWh
From Battery: 0 kWh
Buses Charge (12)
Charging window from 6:00 pm to 8:00 am
Sort by:
Bus ID (A to Z)
38401 Bus ID | 45% Starting SoC% | 206 kWh Energy delivered | 99% Leaving SoC%
Time info
First plug in time: 11:19 pm
Total time spent plugged in: 3h 55m
Active charging time: 3h 49m
Termination time: 3:15 am
Charger 8B
First plug in time: 11:19 pm
Avg. charging power: 54 kW
Max. charging power: 58 kW
Energy delivered: 206 kWh
Termination time: 3:15 am
38402 Bus ID | 89% Starting SoC% | 46 kWh Energy delivered | 99% Leaving SoC%
38404 Bus ID | 53% Starting SoC% | 54 kWh Energy delivered | 67% Leaving SoC%
68801 Bus ID | 51% Starting SoC% | 201 kWh Energy delivered | 99% Leaving SoC%
100kW
0kW
15:00
19:00
Base load
Connection
o issues
Buses
Depot Overview
-125kW
Base load
+200kW
Limit: 200kW
-225kW
Bus load
+800kW
Limit: 200kW
SoC: 23%
234 KWh
Storage
On the road
Charging
In Depot
Show map
14 vehicles are listed
38401 Vehicle ID | On the road Status | 64% SoC% | 173.71 km Est. Range | 1.1 kWh / km Efficiency
38402 Vehicle ID | In depot Status | 92% SoC% | 249.71 km Est. Range | 13:59 Arrival time
38403 Vehicle ID | On the road Status | 55% SoC% | 149.29 km Est. Range | 1.29 kWh / km Efficiency
38404 Vehicle ID | In depot Status | 40% SoC% | 108.57 km Est. Range | 20:58 Arrival time
38405 Vehicle ID | In depot Status | 59% SoC% | 160.14 km Est. Range | 20:59 Arrival time
68801 Vehicle ID | In depot Status | 60% SoC% | 180.86 km Est. Range | 06:21 Arrival time

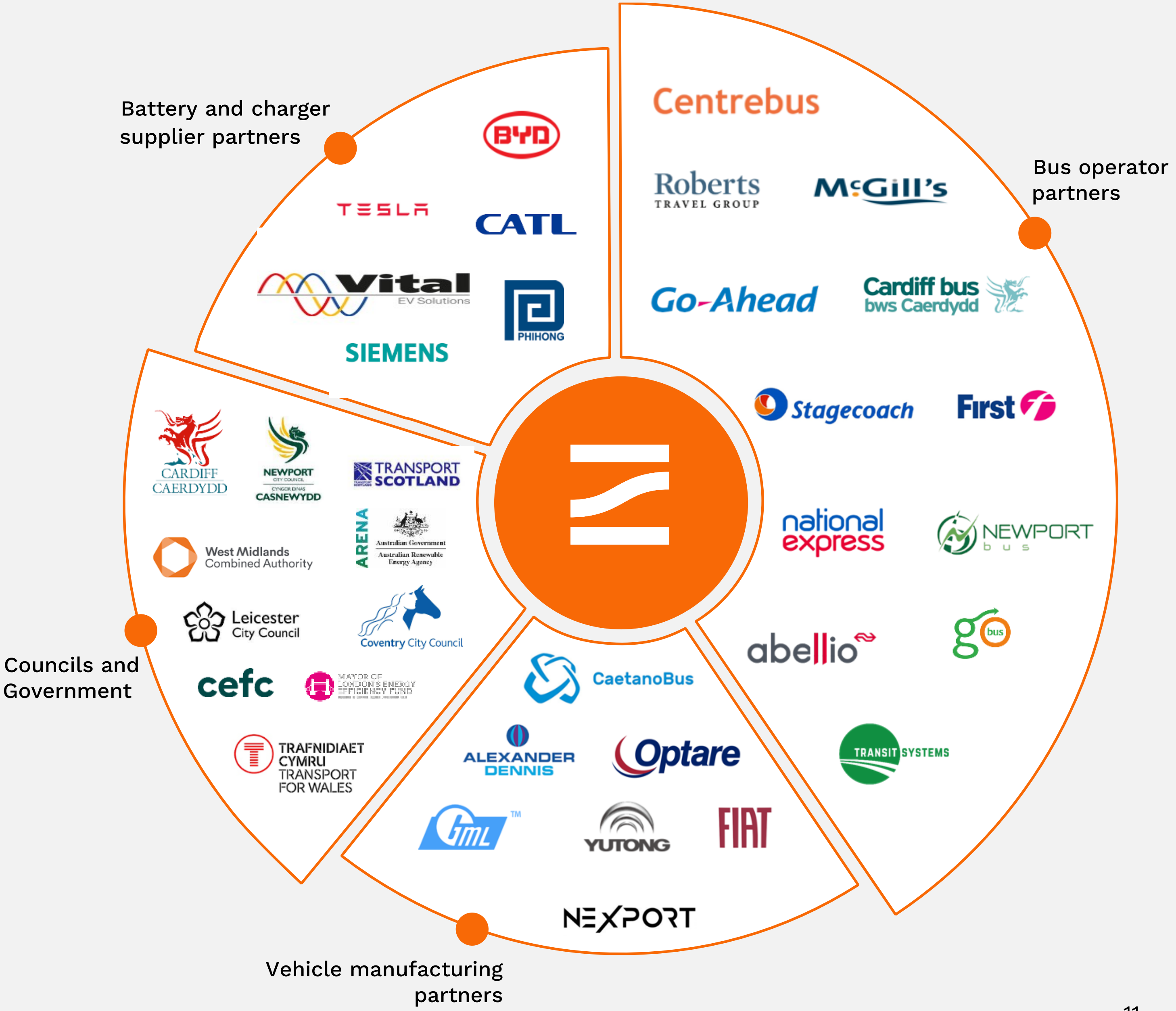


Monitor your operations and track battery performance combining Vehicle and Charger for a holistic view of your fleets operations :

API Integration with Kempower CHARGEYE

We take a partnership approach

- For the long term
- Tailored to you
- Future proofed
- Full data sharing



Vital EV is the appointed UK distributor for Kempower DC EV chargers, offering a wide range of tailored solutions from **SALES** and **RENTAL** to **SERVICE** and **MAINTENANCE**. Our vision is to be the most **TRUSTED** service provider within the EV charging solutions sector by setting **WORLD-CLASS CUSTOMER SERVICE** benchmarks and transforming customer expectations with **HONESTY, INTEGRITY & PASSION.**

- Reputable, Reliable & Robust DC Chargers
- Installation & Commissioning
- 24/7/365 Operations Support
- 4-Hour Service Level Agreements
- API-Based Charge Management Software
- Modular & Scalable Charging Solutions
- Dynamic Power Management
- World-Class Workforce Management Software

KEMPOWER T-SERIES

Mobile DC Charger

- Up to 40kW of DC charging power (dual charging option with 20kW each) for rapid charging
- Simply plug into 5-pin 63A socket for convenient EV charging (adapters available)
- Lightweight design and robust wheels provide easy maneuverability
- Intuitive 7” touchscreen display ensures a user-friendly charging experience
- Quickly and easily link to your charging session via on-screen QR code
- Weatherproof design is perfect for indoor and outdoor applications
- ChargEye remote monitoring and control software
- 500v and 800v DC charging options

Vital EV Solutions TRUST

Simple 3-Step Setup. Rapid DC Charging in 5 Minutes.

KEMPOWER

S-SERIES

Satellite Charging Post

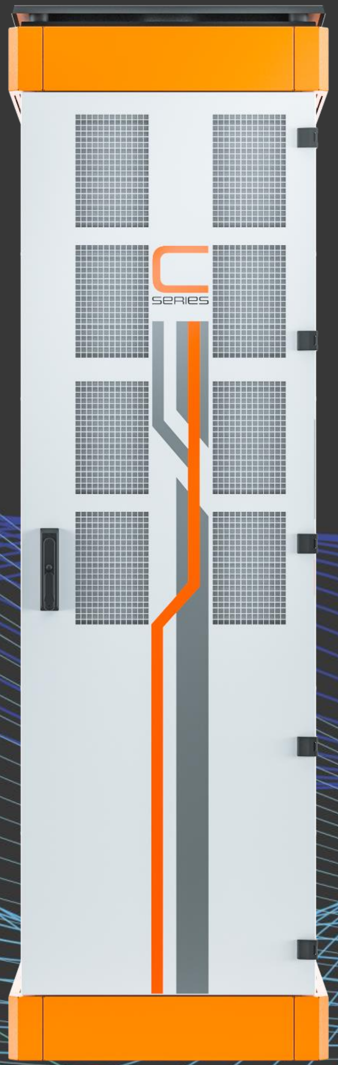
- Single Port and Dual Port options
- Best Power-To-Footprint Ratio in the rapid charging market - up to 350kW from a single post
- Class-leading cable management system improves cable mobility and reduces cable damage
- Access to ChargEye remote monitoring and control software
- Intuitive and user-friendly 7” touchscreen display ensures a smooth and convenient charging experience
- Up to 24 S-Series charging posts from one C-Series cabinet
- Dynamic Power Management available for intelligent power distribution

Up to 350kW with a footprint similar to an A4 sheet.

KEMPOWER

C-SERIES

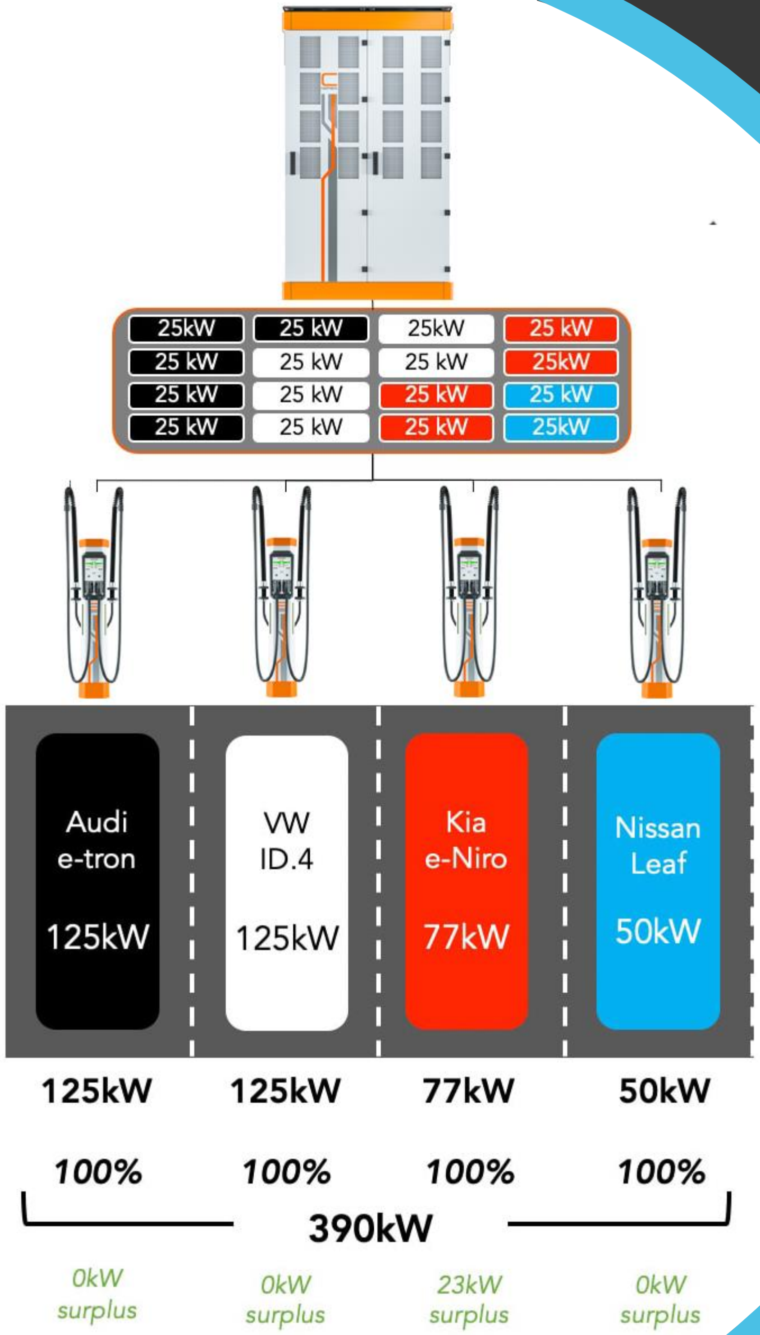
EV Charging Cabinet



- A scalable charging cabinet made up of 50kW power modules
- Available as a single (up to 200kW), double (up to 400kW) or triple (up to 600kW) cabinet
- Up to 24 S-Series charging posts from one C-Series cabinet
- Dynamic Power Management available for intelligent power distribution
- Access to ChargEye API-based remote monitoring and control software
- 4G connectivity for monitoring and maintenance
- 500v or 800v DC charging options

Vital EV Solutions TRUST

Modular & Scalable EV Charging



DYNAMIC POWER MANAGEMENT

The Kempower system constantly monitors the charging power of each EV, and automatically reassigns power modules throughout charging sessions from EVs whose charging power is tapering off, to those that are capable of accepting an extra boost in charging power.

CHARGEYE

All of our Kempower products are available with ChargEye, an API-enabled charge monitoring and management software that allows users to remotely control each charger and access powerful charging insights.

ChargEye includes several algorithms that use A.I. (Artificial Intelligence) machine learning, which it cross references with recorded data to identify potential issues before they arise and maximise charger up-time.

EVDRIVER

Consultancy Services

Fleet EV Charging considerations

Linda Grave

Chargepoint Management Systems

- What is a CMS
- What do YOU want from your CMS
- What are the ownership models

Chargepoint Management Systems

What is a CMS

A cloud-based platform that enables you to manage, monitor and operate your charge units. Often referred to as a Backend.

OCPP (Open Charge Point Protocol) Industry standard https://www.openchargealliance.org/

Hardware with integral CMS –limited features

Agnostic- Works with a large number of hardware manufacturers

Features -Reporting tools and alerts

Access Rights- Admin access rights, set tariffs , add new and block users

Payment-Tariff and bill settlement

What do you want from your CMS

Reliable -Available -Compatible

Access - By App-RFID- open or contactless payment

Reporting – Level of access to pull your own reports

Tech features- integration with your existing systems

Level of support required- In house or external

Billing & Reconciliation –Reimbursement of home charging

What are the ownership models

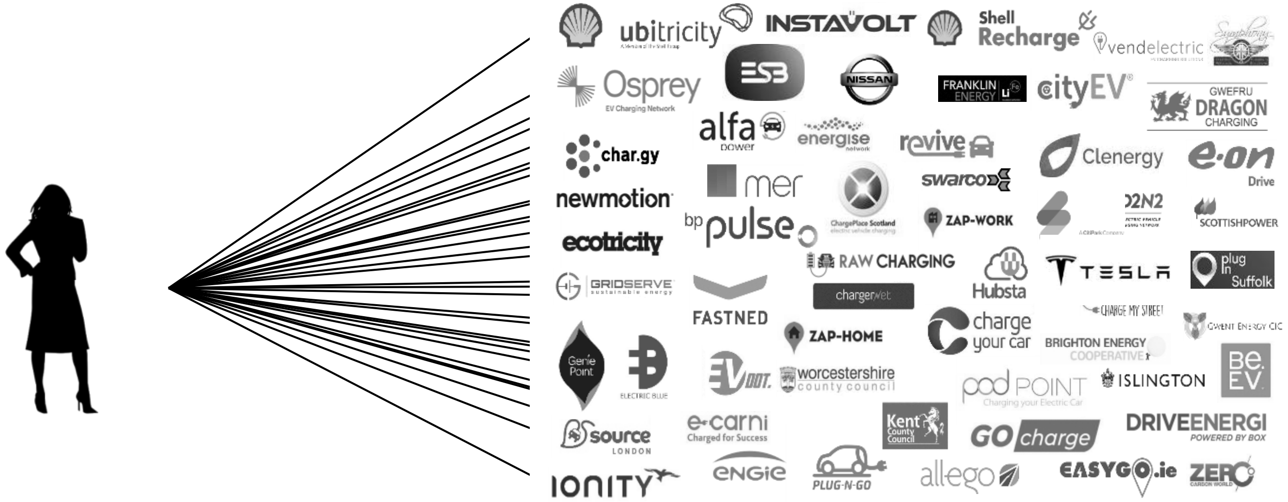
All Inclusive- The back-end is part of the service along with supply and installation of the hardware, you pay a monthly fee for the service , you also pay transaction fees.

SaaS Rented- You purchase your hardware and paid for the installation, you then pay for the Operation and Maintenance services monthly + transaction fees.

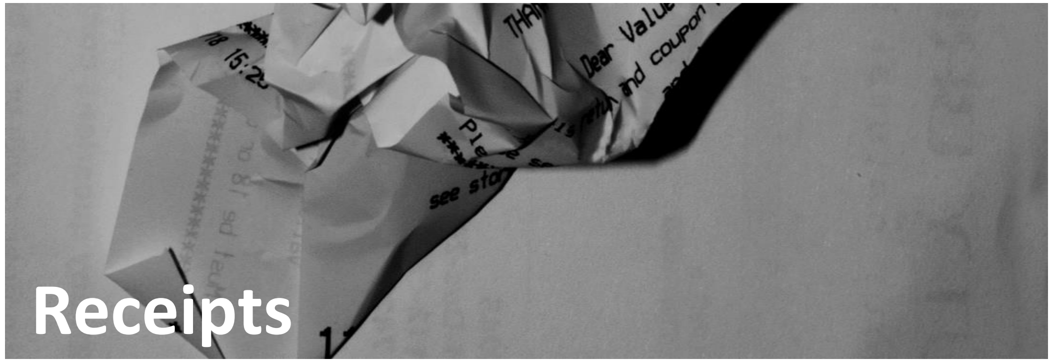
Licenced- If you wish to be a CPO (charge point operator) yourself you can chose to licence your own backend and operate this yourself , with a white labelled solution.

Build your own- This option is normally chosen after having utilised one of the previous options, once the organisation has decided to grow and own more of the value chain.

The public charging challenge



80+ charging networks



PAUA

Your solution from Paua

Find ❱ Charge ❱ Pay

Paua networks

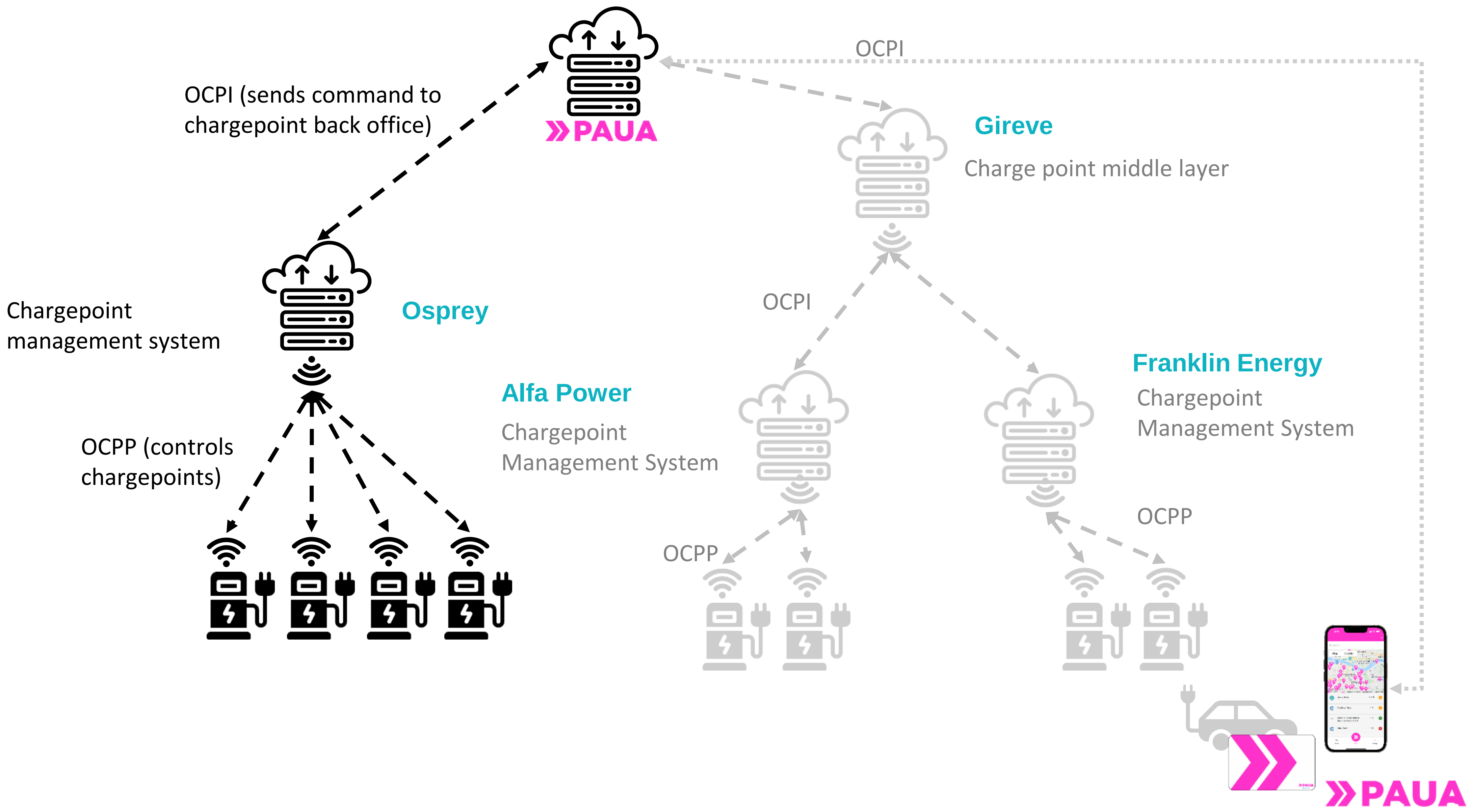
4,300 in UK

29,000 in EU

Ongoing discussions

»PAUA

How we do it



OCPI (sends command to chargepoint back office)
PAUA
OCPI
Gireve
Charge point middle layer
Chargepoint management system
Osprey
OCPI
Franklin Energy
Chargepoint Management System
Alfa Power
Chargepoint Management System
OCPP (controls chargepoints)
OCPP
OCPP
PAUA

EVDRIVER

Consultancy Services

Experts in EV Charging Infrastructure and Management

Helping businesses and fleets to make informed decisions

BATTERIES AND EV CHARGING INFRASTRUCTURE

WHO WE ARE

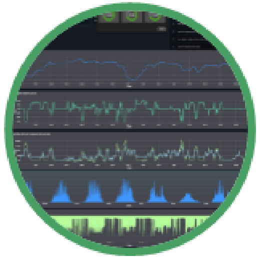
World leading innovators in energy storage & circular economy

- Dedicated to the design, manufacture and operation of world class energy storage systems.
- Management team with mature experience from automotive and energy sectors.
- Aiming to achieve ambitious international growth

Hardware and software system integrators

Manufacturing supply chain developers

Sales, operation and customer service providers



Project development and finance

CONNECTED ENERGY Advanced Energy Storage Solutions

THE E-STOR ENERGY STORAGE SYSTEM

E-STOR uses second life EV batteries.

- Installed, operational and proven technology
- Modular, flexible design for low cost scalability
- Battery/OEM agnostic
- Integrates existing, reliable technologies
- Operating system monitors performance and optimises system
- Simple, low cost installation and maintenance

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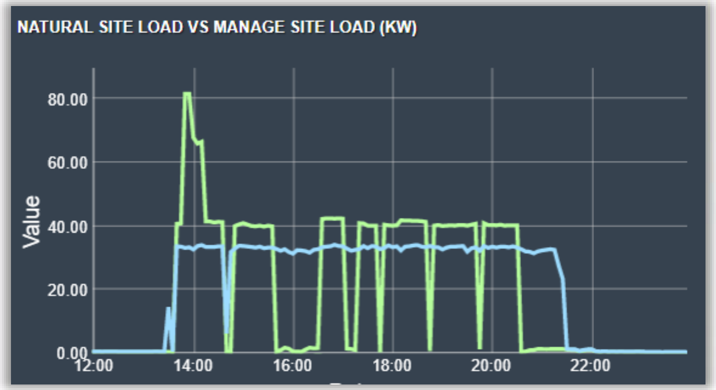
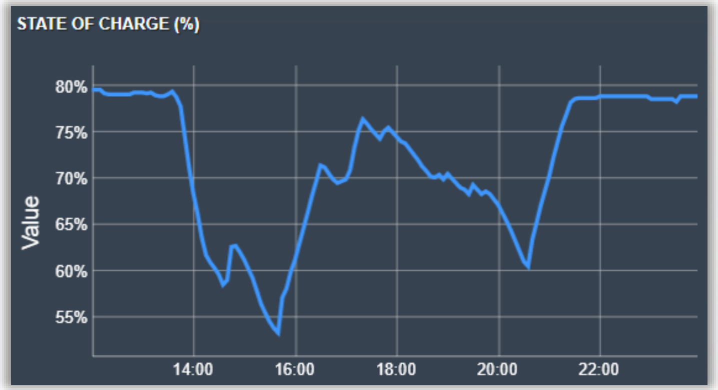
CHARGER MANAGEMENT

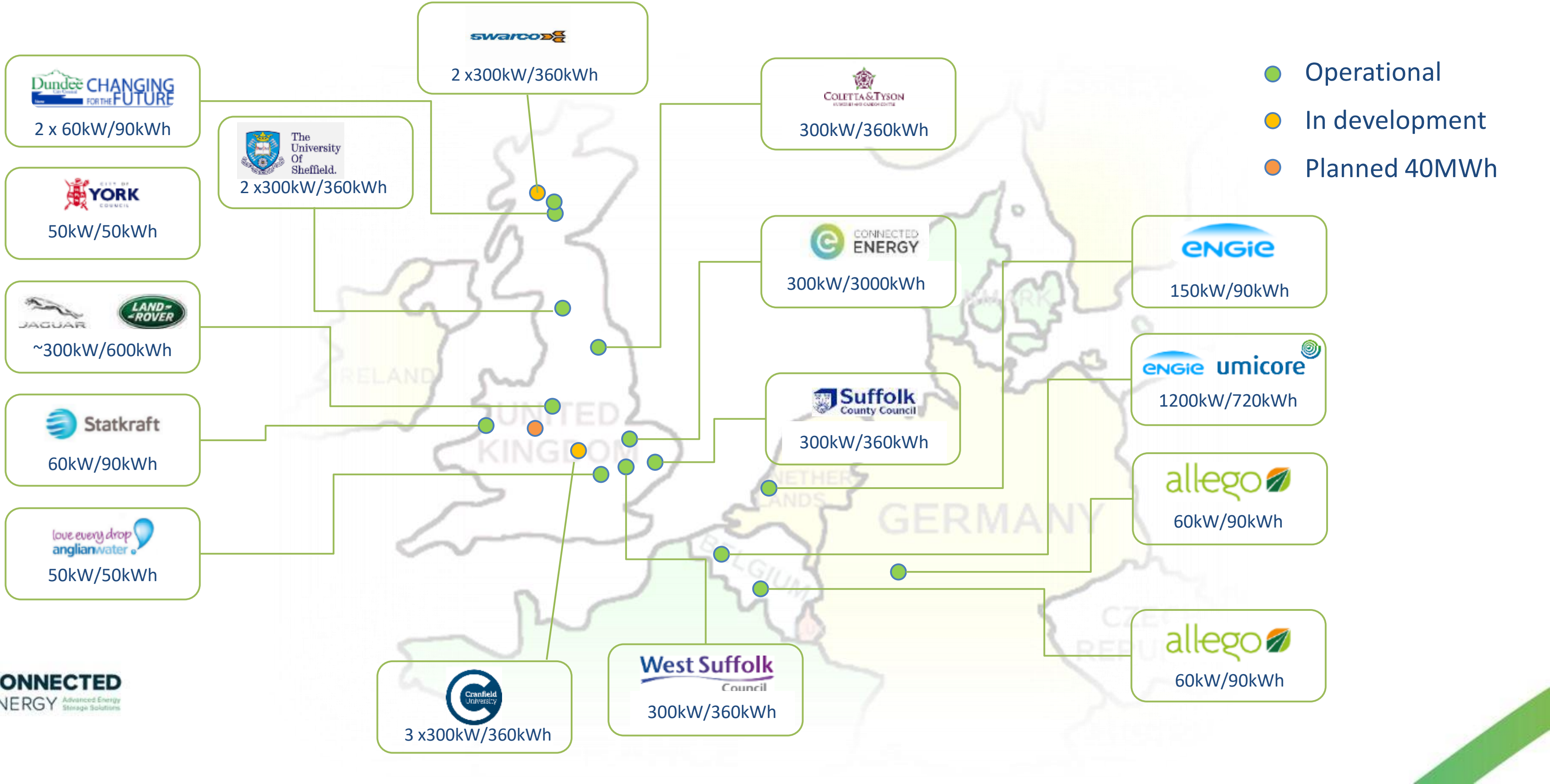
ALLEGO: Active battery management of rapid chargers on a constrained network

- Site has a maximum import size of 35 kW
- Installed 2 x 50 kW rapid chargers installed
- Will cause a trip and blackout to the service station
- No option for reasonable grid upgrades or generation
- The battery dischargers to provide support power when needed
- When there is capacity available the battery recharges





OUR SYSTEMS



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TAXI CHARGING

Our Dundee installation manages a range of separate chargers whilst maximising generation usage from solar the canopies

- An E-STOR 60 kW / 90 kWh is installed
- Providing solar capture when there is surplus
- Peak Shaves to maintain a maximum import level
- Sees nearly full time usage of chargers
- Total charger peak load seen of 320 kW
- 99% of solar generated is used on site (up from 90%)

Dundee City Council www.dundeecity.gov.uk CHANGING FOR THE FUTURE

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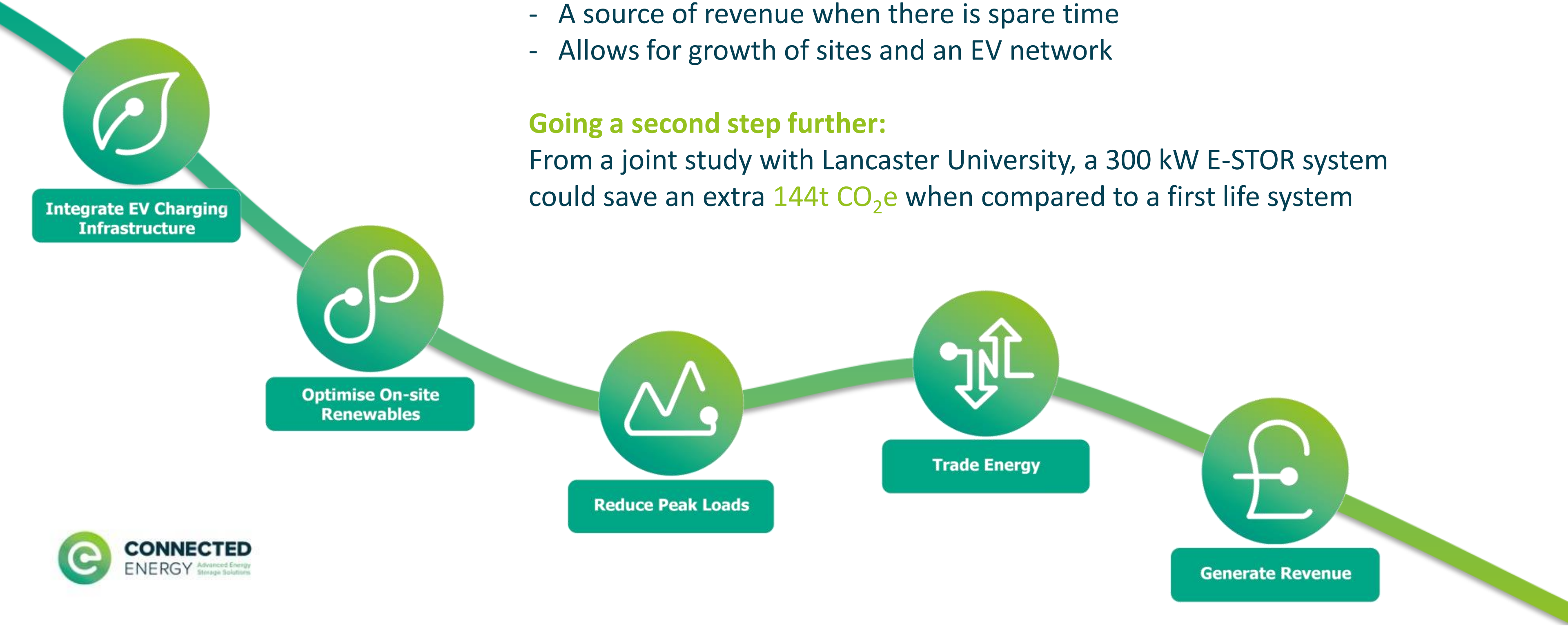
BENEFITS OF USING A BATTERY

- Avoid or minimise costly infrastructure upgrades
- Provide extra flexibility to your site
- A source of revenue when there is spare time
- Allows for growth of sites and an EV network

Going a second step further:
From a joint study with Lancaster University, a 300 kW E-STOR system could save an extra 144t CO_2e when compared to a first life system



CONNECTED ENERGY

USING AN E-STOR FOR EV FLEETS

- EV Fleets pose an interesting challenge for establishing a reliable charging network
- Want to minimise down time of the fleet, chargers should be able to run when they are needed
- Typically shift patterns result in seeing large blocks of time when vehicles are returning to be charged
- This concentrates the demand for power and will likely need managing, connection upgrades can cost upwards of £100k!
- As companies grow the adoption of EV’s will also increase, meaning it wont just be the fleet that will want to charge
- With such large volumes of energy being used, being able to forecast and act on price signals will optimise the cost of running a fleet

WHAT BATTERY IS RIGHT FOR MY FLEET

From our experience no site is the same and needs to be modelled. **We are here to help!**

- Typically a battery can reduce the peak power of a charging network by about a third
- Integration with EV chargers or Building management systems will allow for full optimisation
- Smooth data transfer and management platforms will keep the fleet running smoothly
- Batteries will need replacing over time. Make sure the degradation is factored in as well as their cost

Shopping list for modelling:

- ❑ Numbers of vehicles
- ❑ Battery sizes of the fleet
- ❑ Numbers of chargers and their power ratings
- ❑ Expected profile of how the fleet will arrive to be charged
- ❑ Demands for when key vehicles must be ready
- ❑ Half hourly energy data for the site
- ❑ Forecasts of any generation on site
- ❑ Connection capacities for the site

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Thank you

CONNECTED ENERGY Advanced Energy Storage Solutions

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