Transport | Energy Infrastructure | Knowledge & Enterprise

cenex

Welcome to the BETT Workshop

Victor Lejona

Modelling & Analysis Team Leader
victor.lejona@cenex.co.uk

Transport | Energy Infrastructure | Knowledge & Enterprise

cenex

4 years and 1 day ago in this very room…

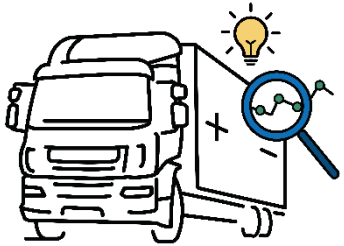
Transport | Energy Infrastructure | Knowledge & Enterprise

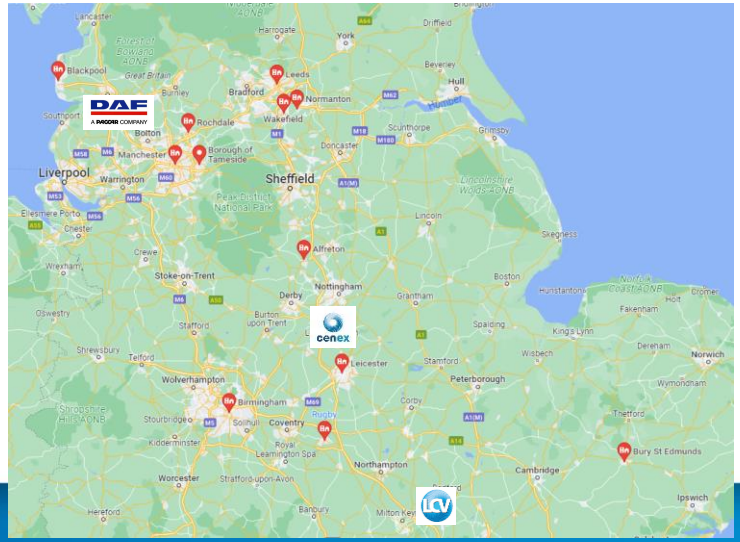
cenex

Battery Electric Truck Trial (BETT)

- 18-month eHGV demonstrator
- Twenty 19-tonne rigid DAF trucks
- 9 public sector fleets across England

BETT
BATTERY ELECTRIC TRUCK TRIAL





Transport | Energy Infrastructure | Knowledge & Enterprise

cenex

Project partners

Innovate UK

- Provided £10m funding for vehicles, charging infrastructure and monitoring equipment/tools
- Regular monitoring of project status

DAF A PACCAR COMPANY

LEYLAND TRUCKS A PACCAR COMPANY

- Manufactured vehicles at Leyland factory
- Procured charging hardware and software
- Delivered vehicles to fleets incl. training on driving and charging
- Subcontracted Cenex to collect and analyse trial data

cenex

- Collect and analyse data
- Quantitative data via telemetry
- Qualitative data via surveys and interviews with drivers and fleet managers
- Quarterly summary reports
- Deep dive reports
- Public dissemination via website

Transport | Energy Infrastructure | Knowledge & Enterprise

cenex

https://bett.cenex.co.uk/

Live Data

20	248,084 kWh	18,667	255,875 km
TRUCKS IN OPERATION	ELECTRICITY CONSUMED	JOURNEYS	DISTANCE TRAVELLED

Performance

RANGE ON FULL CHARGE

267 km	301 km	224 km	290 km
AVERAGE	RURAL	URBAN	MOTORWAY

DAILY DISTANCE TRAVELLED

93 km
AVERAGE

573 km
MAX

AVERAGE UTILISATION

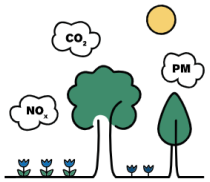
2 hours 46 minutes	2 hours 9 minutes
DRIVING PER DAY	CHARGING PER DAY

DAILY BATTERY USE

39 % SoC
AVERAGE

Environment

- 188.0 TONNES OF CO_2 SAVED
- 53.8 KGS OF NO_x SAVED
- 767 GRAMS OF PM SAVED

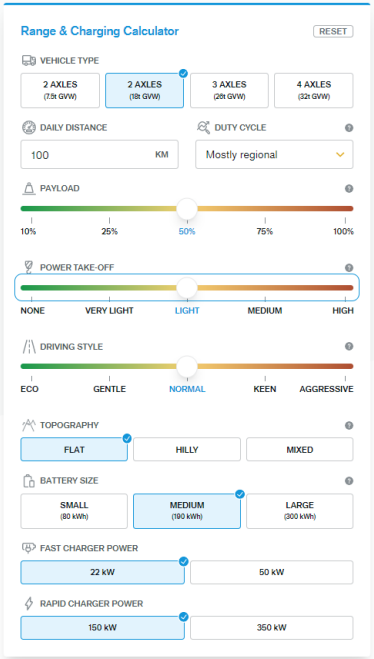


Economics

19 p
RUNNING COST SAVINGS PER KM

£ 47,616
FUEL COST SAVINGS ACROSS THE TRIAL

Fleet Planning Tool



Your truck can drive:

187 km	269 km
RANGE ON A FULL CHARGE	MAXIMUM RANGE WITH OPPORTUNITY RAPID CHARGING

Based on your daily mileage:

53%	102 kWh
DAILY BATTERY CHARGE USED	DAILY ENERGY USED

Daily time to recharge:

4:40 hours	0:40 hours
22 KW FAST CHARGER	150 KW RAPID CHARGER

Fleet Planning Tool

Our Fleet Planning Tool gives you more detailed results based on operation, costs, charging time and environmental benefits of a fleet of Battery Electric Trucks.

Start Now ▶

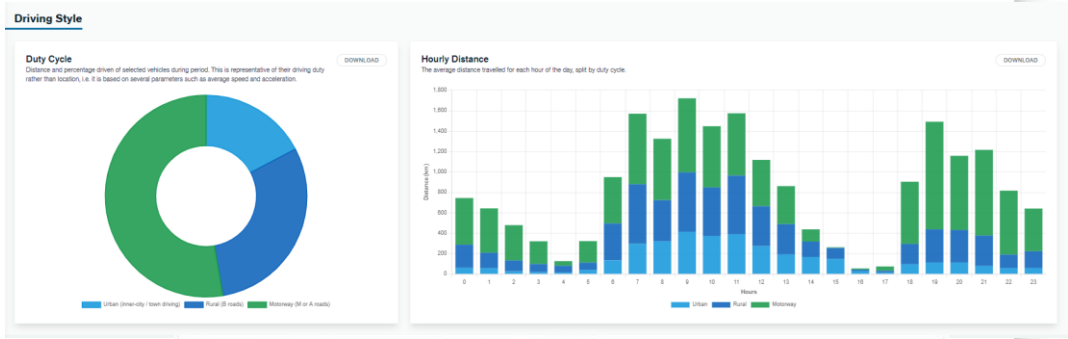
+TCO
+Emissions savings
+Chargepoint needs

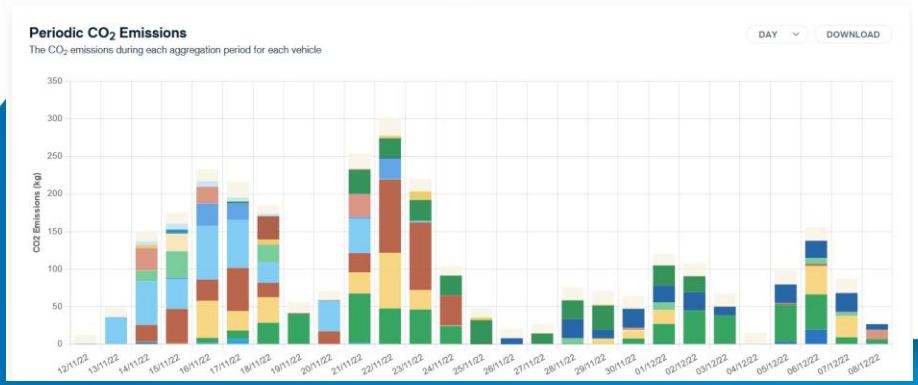
Transport | Energy Infrastructure | Knowledge & Enterprise

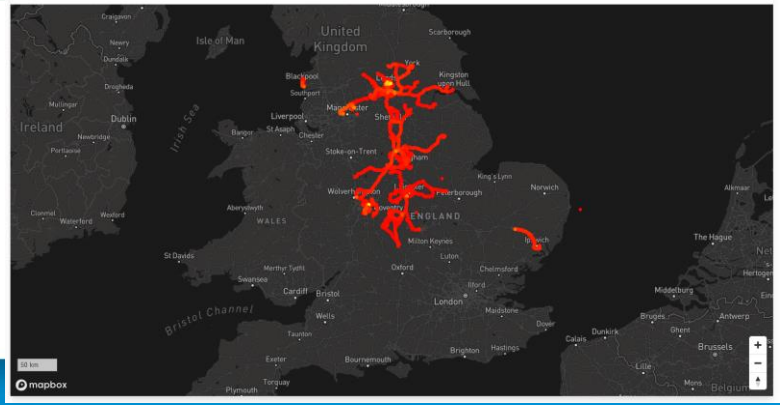
cenex

https://bett.cenex.co.uk/

Private dashboard for fleets & DAF







Participating fleets

Blackpool Council — 1 vehicle, Blackpool, moving their iconic illuminations

ESPO — 2 vehicles, Leicester, delivering public sector goods

NHS The Leeds Teaching Hospitals NHS Trust — 2 vehicles, Leeds, delivering bins to and from hospitals

NHS Supply Chain — 8 vehicles, Rugby, Alfreton, Normanton, Bury St. Edmunds, delivering supplies to hospitals

NHS Northern Care Alliance NHS Foundation Trust — 2 vehicles, Manchester, delivering bed linen to and from hospitals

Participating fleets

ROCHDALE BOROUGH COUNCIL

1 vehicle, Rochdale, delivering wheelie bins

Tameside Metropolitan Borough

1 vehicle, Tameside, delivering wheelie bins

NHS University Hospitals Birmingham NHS Foundation Trust

1 vehicle, Birmingham, delivering supplies to hospitals

ypo

2 vehicles, Wakefield, delivering supplies to schools

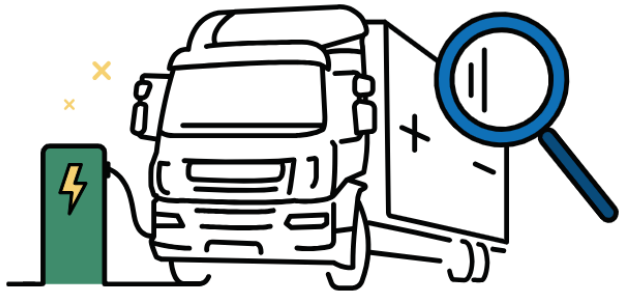
Trialled vehicles

- 19t GVW rigid, 2 axles, 5.3m or 5.85 m wheelbase, 7.3t to 9.3t payload.
- 22 kW electric power take-off
  - 8 vehicles have temperature-controlled bodies
  - All vehicles have tail-lifts
- 250 kWh usable battery, 280 km nominal range.
- 650V LFP battery.
- 22kW AC charging, 12 hours 0% to 100%.
- 150kW DC charging, 1 hour 20% to 80%.

Transport | Energy Infrastructure | Knowledge & Enterprise

cenex

Project timeline



2021

Q3

Project kick-off

Q4

Vehicle construction
Chargepoint installation
Telemetry setup

2022

Q1

Website development
Pre-trial interviews and surveys

Q2

Public trial launch (*April 2022*)

Real-world vehicle demonstration with fleets
Quarterly reporting and dissemination – **bett.cenex.co.uk**

2023

Q3

On-road demonstration finishes (*September 2023*)

Post-trial interviews and surveys

Q4

Final reporting (incl. public white paper)

Transport | Energy Infrastructure | Knowledge & Enterprise

cenex

Today's agenda

Time	Topic	Organisation	Person	Job title
09:40	Zero Emission Road Freight - The funder's perspective	Innovate UK	Dr Isabella Panovic	Programme Manager – Zero Emission Road Freight
09:55	Trial monitoring, data analysis, results and insights	Cenex	Tom Allerton	Senior Technical Specialist
10:20	The OEM's perspective: eHGVs made in the UK	Leyland Trucks	Chris Griffiths	Chief Engineer
10:40	The chargepoint provider's perspective: planning, installation and operation	Paccar	Adam Bennett	EV & Sustainability Manager
10:55	The fleets' perspective: end user experience driving and charging eHGVs	Prohire, Progreen	Michelle Miles	Head of ProGreen & Group Marketing
11:15	EV Rally: The Capital City Challenge	DAF	Phil Moon	Marketing Manager

UKRI Innovate UK | cenex | LEYLAND TRUCKS A PACCAR COMPANY | progreen by prohire | prohire The future of fleet. | DAF A PACCAR COMPANY

Transport | Energy Infrastructure | Knowledge & Enterprise

cenex

On to our first speaker…

UKRI Innovate UK

Dr Isabella Panovic

Programme Manager – Zero Emission Road Freight

Innovate UK

Cenex Events

Cenex-LCV & Cenex-CAM 2023

6th – 7th Sept 2023

UTAC Millbrook

Zero Emission Road Freight – The Funder's Perspective

Dr Isabella Panovic, Programme Manager - Zero Emission Road Freight

Programme context

- End sale of new non-zero emission HGVs by 2040/2035
- Many predicting BEV's to be cost competitive before 2035
- UK committed to decarbonising electricity system by 2035

ZE HGV demonstrations were recommended by the Committee for Climate Change, included in the 'ten point plan for a green industrial revolution' and the 'Transport Decarbonisation Plan'.

Innovate UK: delivery of the **Zero Emission Road Freight Demonstration Programme** (ZERFD) in partnership with the Department for Transport

The Team: Alistair Barnes, Senior Programme Manager and Isabella Panovic, Programme Manager

UKRI Innovate UK

HM Government

Previous activity – Phase 1

HM Government

FY 21/22: £20 million investment funded by the Department for Transport:

- Supply chain technology (inc. hydrogen refuelling, motor development, trailers)
- Feasibility studies for on-road demonstrations
- Supporting uptake of battery electric rigid HGVs

News story

Road freight goes green with £20 million funding boost

Government encourages fleet operators to convert to battery-electric vehicles in the transition to zero emission road freight.

From: Department for Transport, The Rt Hon Grant Shapps MP, and Iain Stewart MP

Published 27 July 2021

UKRI Innovate UK

Zero Emission Road Freight Demonstrations – Phase 2

- Large 5 year on-road demonstrations of **battery electric** and **hydrogen fuel cell** zero emission HGVs
- Increases operator confidence and government understanding of various ZE HGVs and their infrastructure
- Informing decision making via data collection and dissemination activity

News story

£200 million boost to rollout of hundreds more zero-emission HGVs

Transition to zero-emission trucks will help improve air quality, create greener jobs and reduce reliance on imports of foreign oil.

From: Department for Transport and Trudy Harrison MP

Published 12 May 2022

UKRI Innovate UK

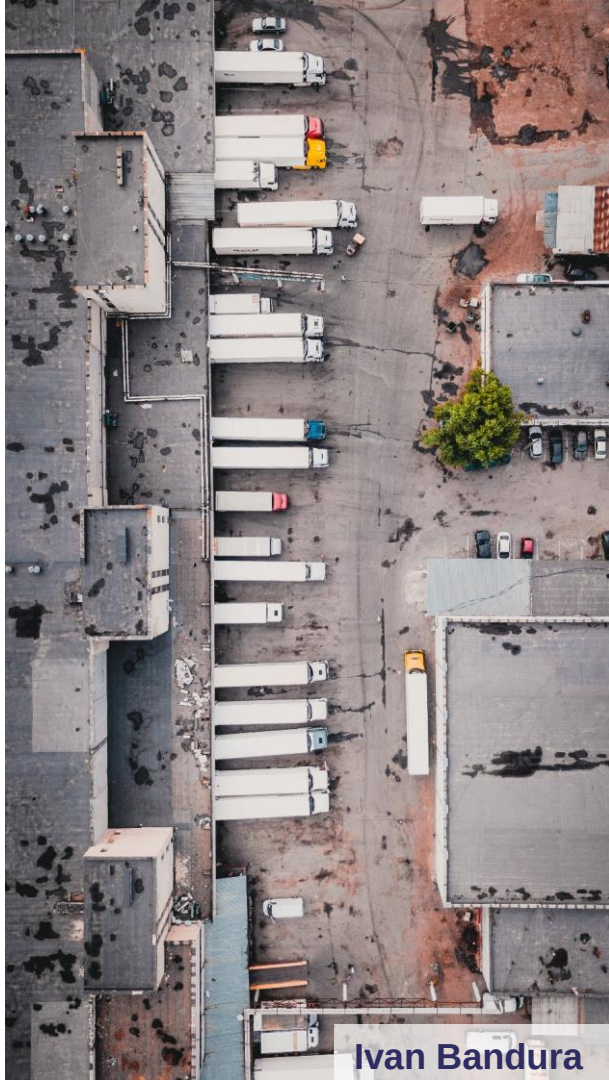
HM Government

Zero Emission Road Freight Demonstrations (ZERFD)

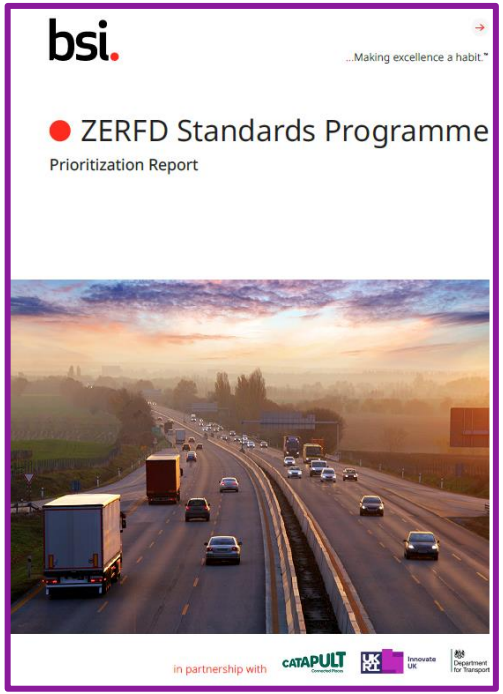
- Demonstration of **battery electric** and **hydrogen** fuel cell trucks and state of the art infrastructure
- Focus: heaviest vehicles and the longest routes, will include many operators and duty cycles (+ refrigeration)
- Timeline:
  - Projects starting this year
  - Announcement of winners soon
  - Two years funded to source trucks and infrastructure
  - Vehicles must be demonstrated for 5 years
- Projects will be high profile: many OEMs involved publicly accessible infrastructure

UKRI Innovate UK

HM Government



bsi/CPC Publication



bsi and Connected Places Catapult have recently released a report as an output of the work package on Standards Development led by bsi as part of ZERFD.

The publication provides a summary of the standards and regulations analysis and engagement work undertaken between December 2022 and June 2023.

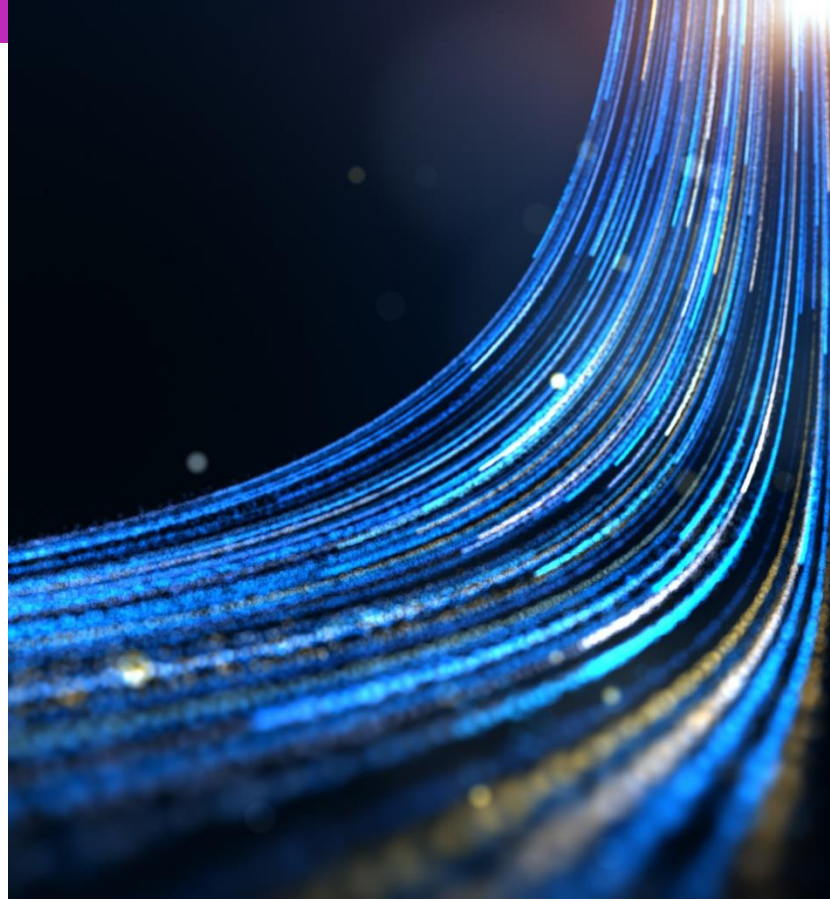
HM Government

Innovate UK

HM Government

ZERFD - Next Steps

- Phase 2 projects are launching in the next few months and in some cases have already started
- Entering into the procurement phase for ZERFD phase 2 – vehicle purchasing and infrastructure preparation
- Dissemination and engagement about the programme, including sharing of phase 1 project outputs



UKRI Innovate UK

HM Government

Transport | Energy Infrastructure | Knowledge & Enterprise

cenex

Data Analysis Results and Insights

Tom Allerton

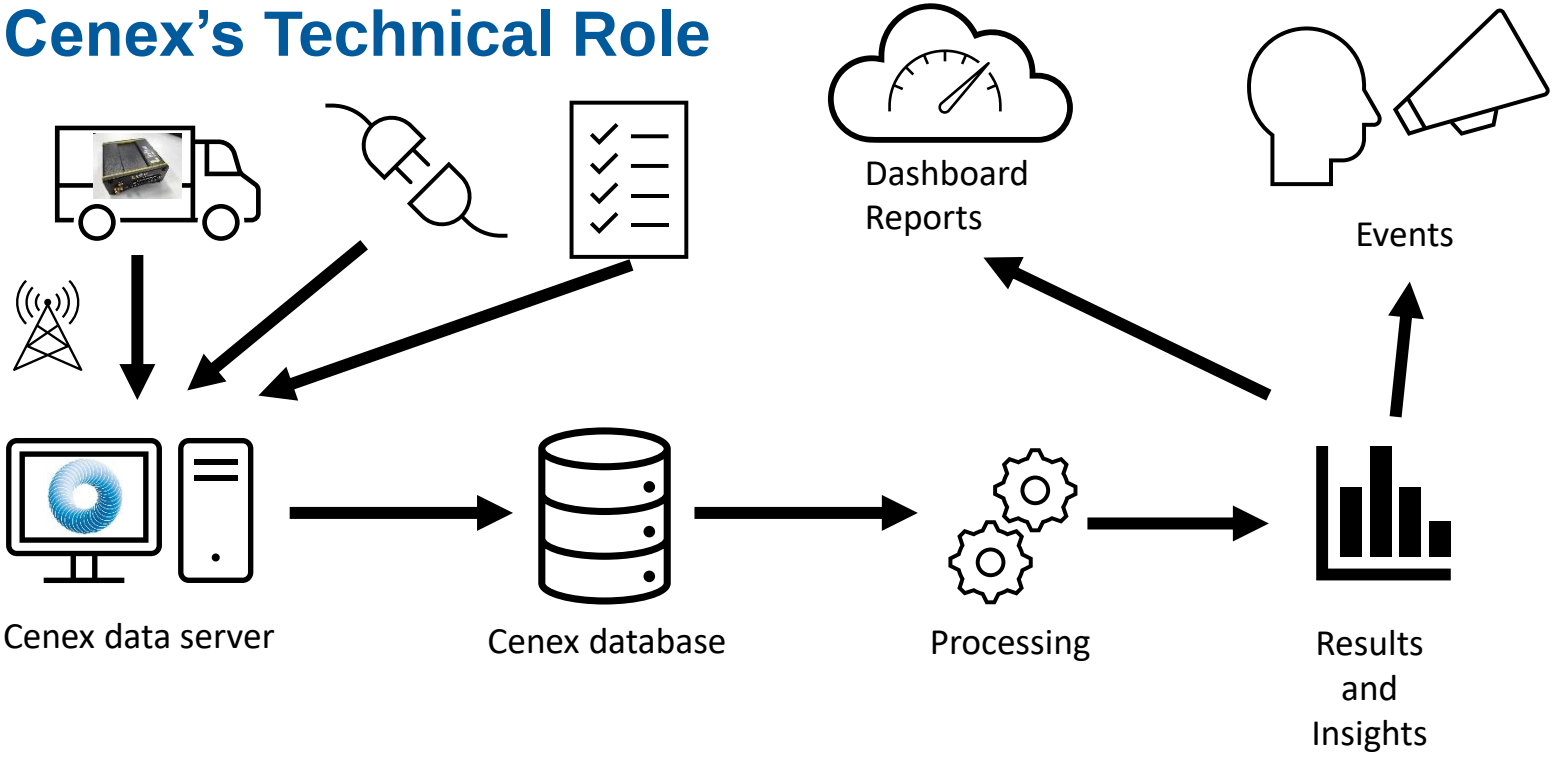
Senior Technical Specialist

tom.allerton@cenex.co.uk

Transport | Energy Infrastructure | Knowledge & Enterprise

cenex

Cenex's Technical Role



Transport | Energy Infrastructure | Knowledge & Enterprise

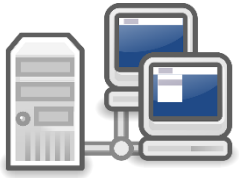
cenex

Headline Numbers

Transport | Energy Infrastructure | Knowledge & Enterprise

cenex

Lots of Data



Just over 15 billion data points recorded, taking up 1.3 TB in our database.

A little under 57 GB of raw (compressed) data downloaded from the loggers.

Almost 37,000 data files.

Nearly 19,000 individual journeys identified.

21,000 hours (875 days or 2.4 years) of vehicle activity including:

- 8,600 hours of active operation.
- 5,200 hours of fast charging.
- 1,800 hours of rapid charging.

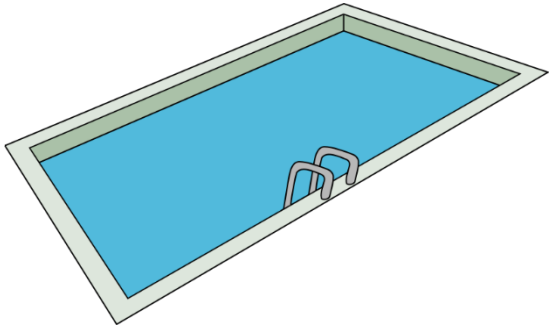
Transport | Energy Infrastructure | Knowledge & Enterprise

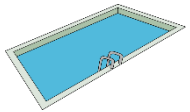
cenex

Distance Travelled

Energy Consumption

With the energy used you could make enough tea to fill…





1.15 Olympic swimming pools.

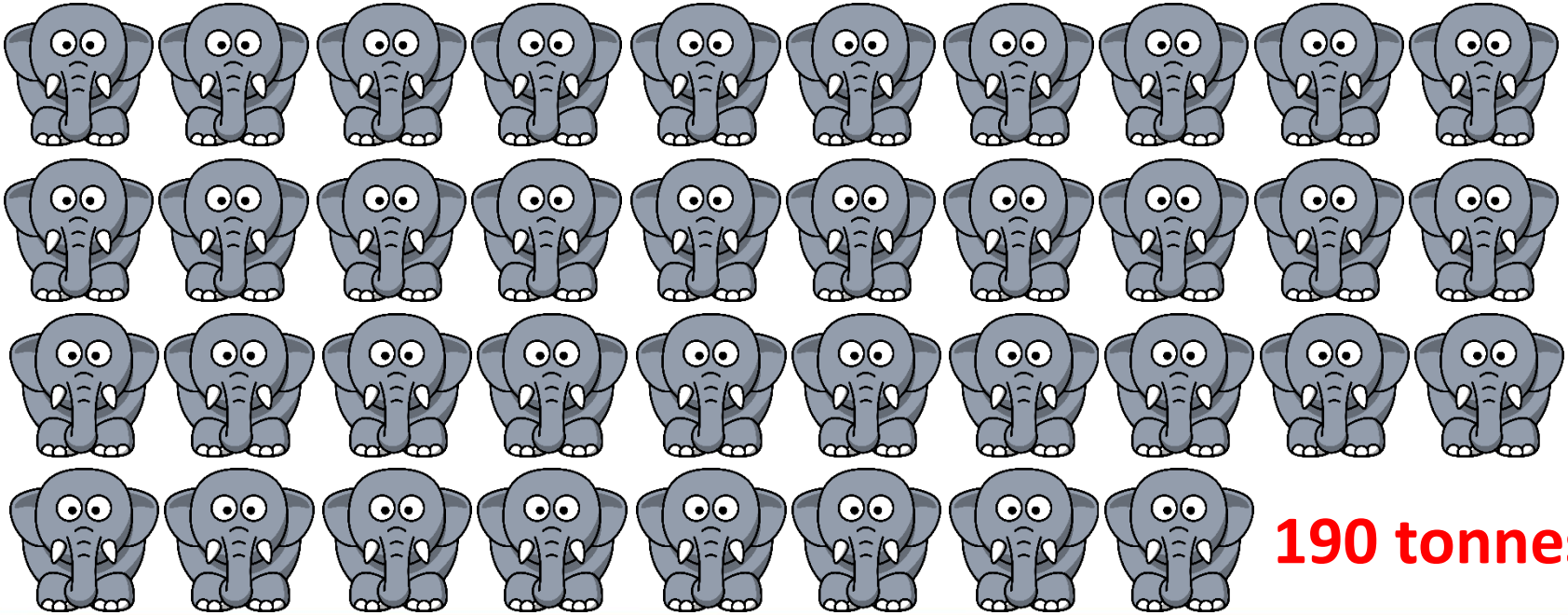
250,000 kWh

Requiring 1.4 million kettles running for 83,000 hours (9.5 years).

Needing about 20,000 cows' worth of milk.

Environmental Benefits

- The CO_2 saved would weigh as much as…



190 tonnes

Transport | Energy Infrastructure | Knowledge & Enterprise

cenex

Best of BETT

- 484 km travelled in one day (573 km in EV Rally)
- 441 kWh used in one day
- 09:58 hours worked in one day (10:02 in EV Rally)
- 527 kWh charged in one day

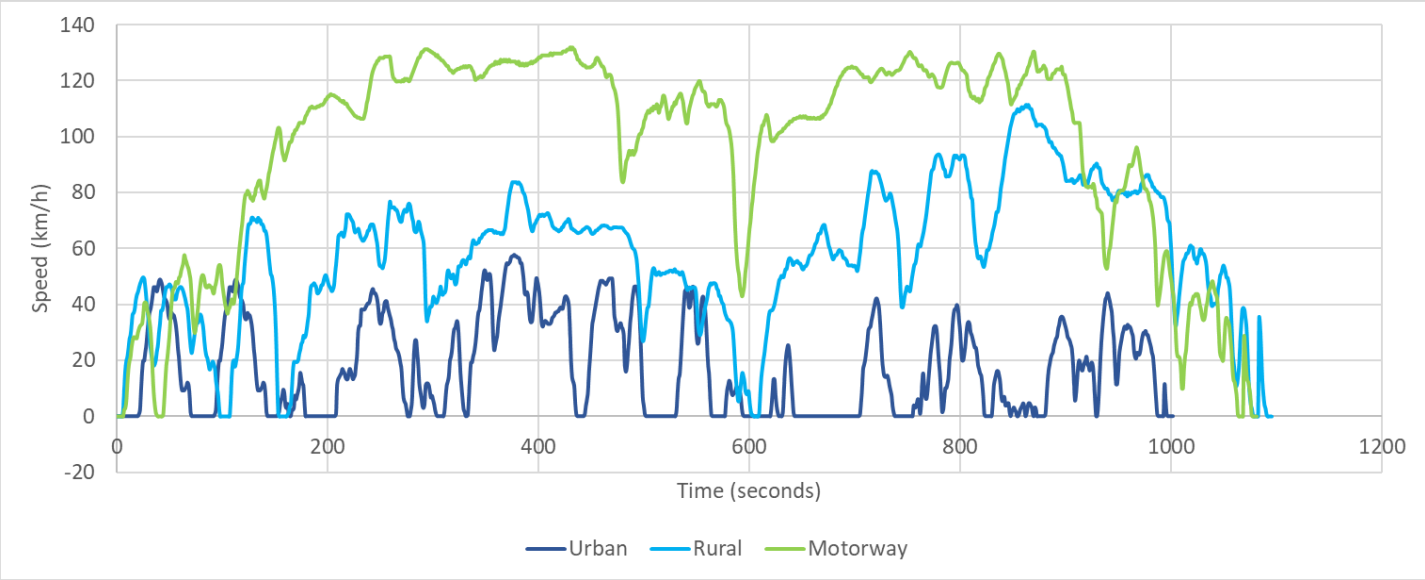
Transport | Energy Infrastructure | Knowledge & Enterprise

cenex

Deep Dives

Drive Cycle Efficiency and Regeneration

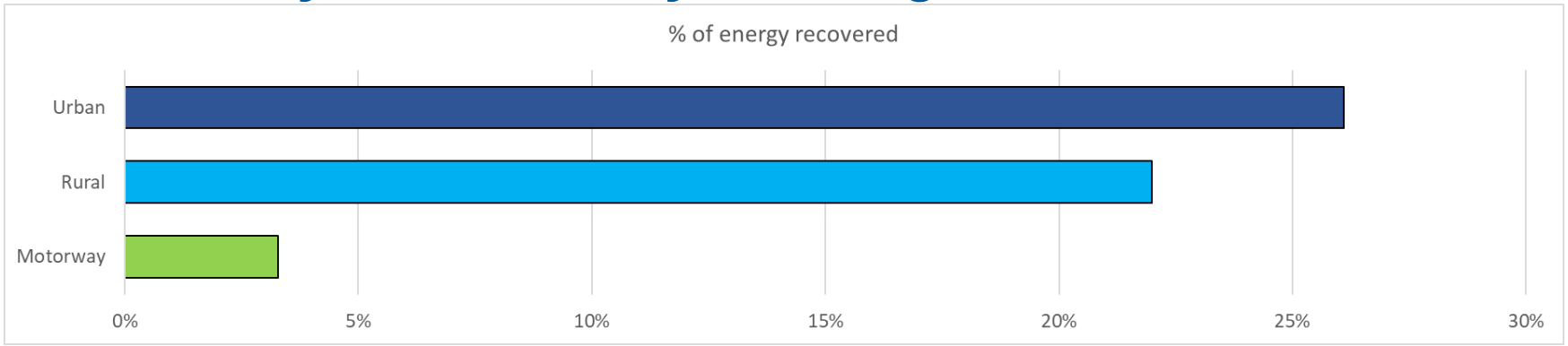
- We split driving into urban, rural and motorway segments

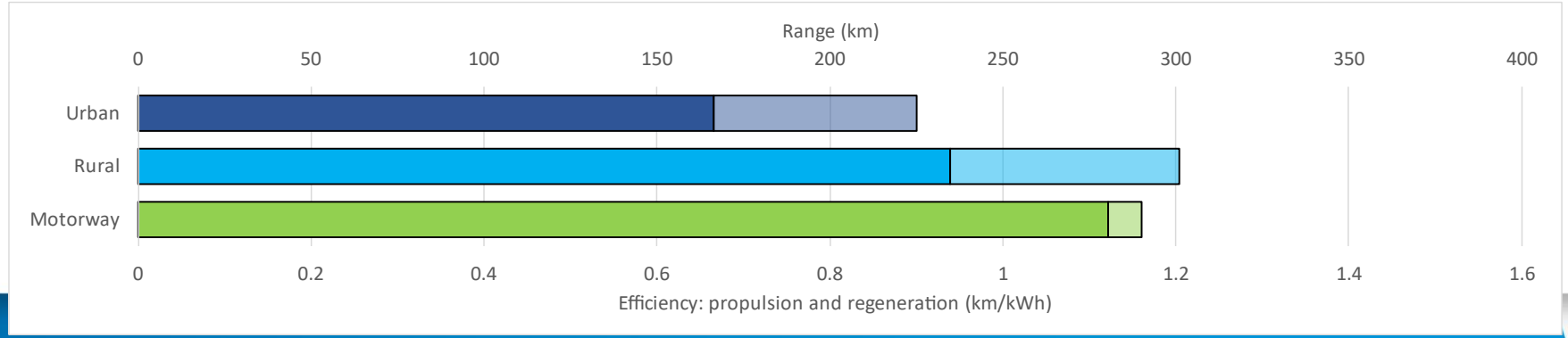


Transport | Energy Infrastructure | Knowledge & Enterprise

cenex

Drive Cycle Efficiency and Regeneration



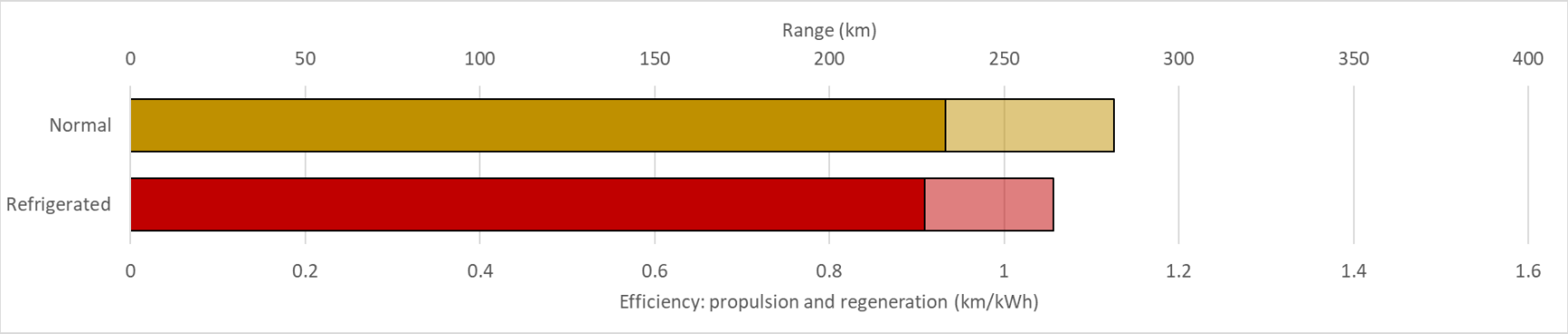


Transport | Energy Infrastructure | Knowledge & Enterprise

cenex

Drive Cycle Efficiency

Overall efficiency and range: **1.08 km/kWh** and **270 km**



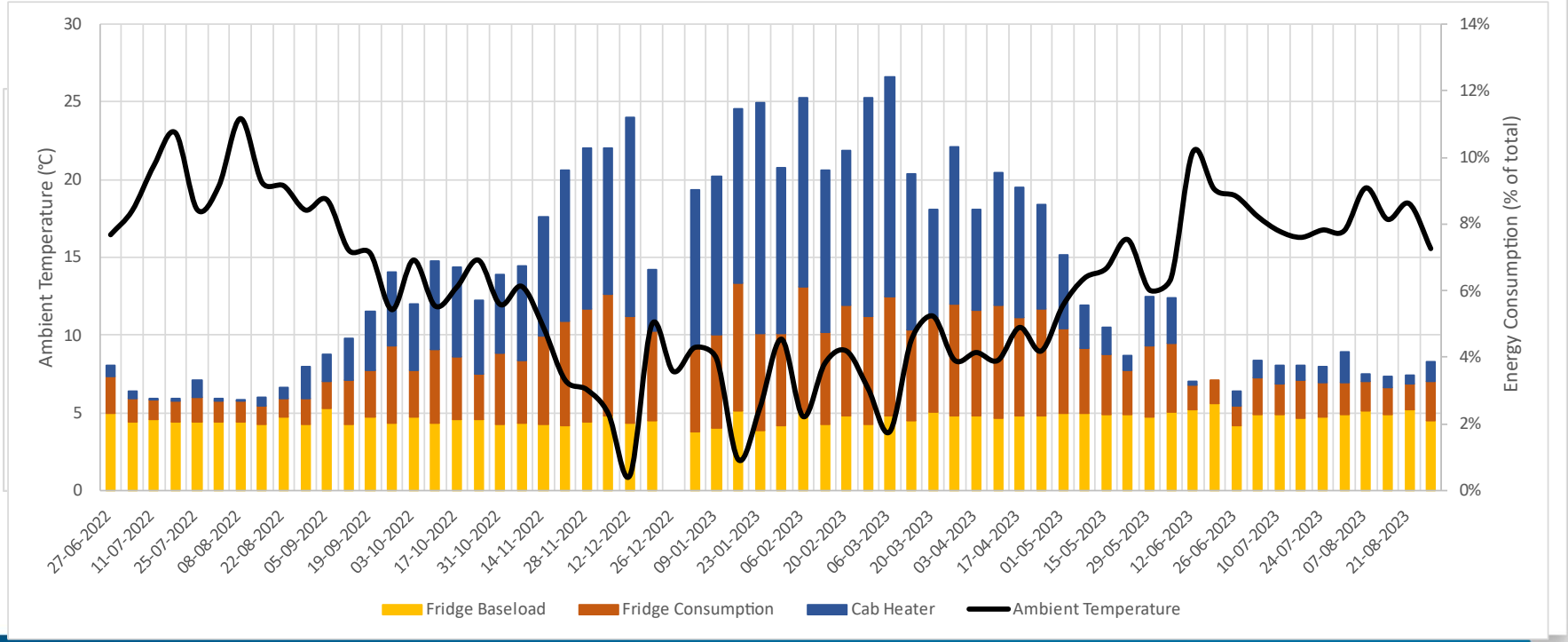
The picture is more complex, this varies by payload, weather and ancillaries.

The difference above is not for the reason you think!

Transport | Energy Infrastructure | Knowledge & Enterprise

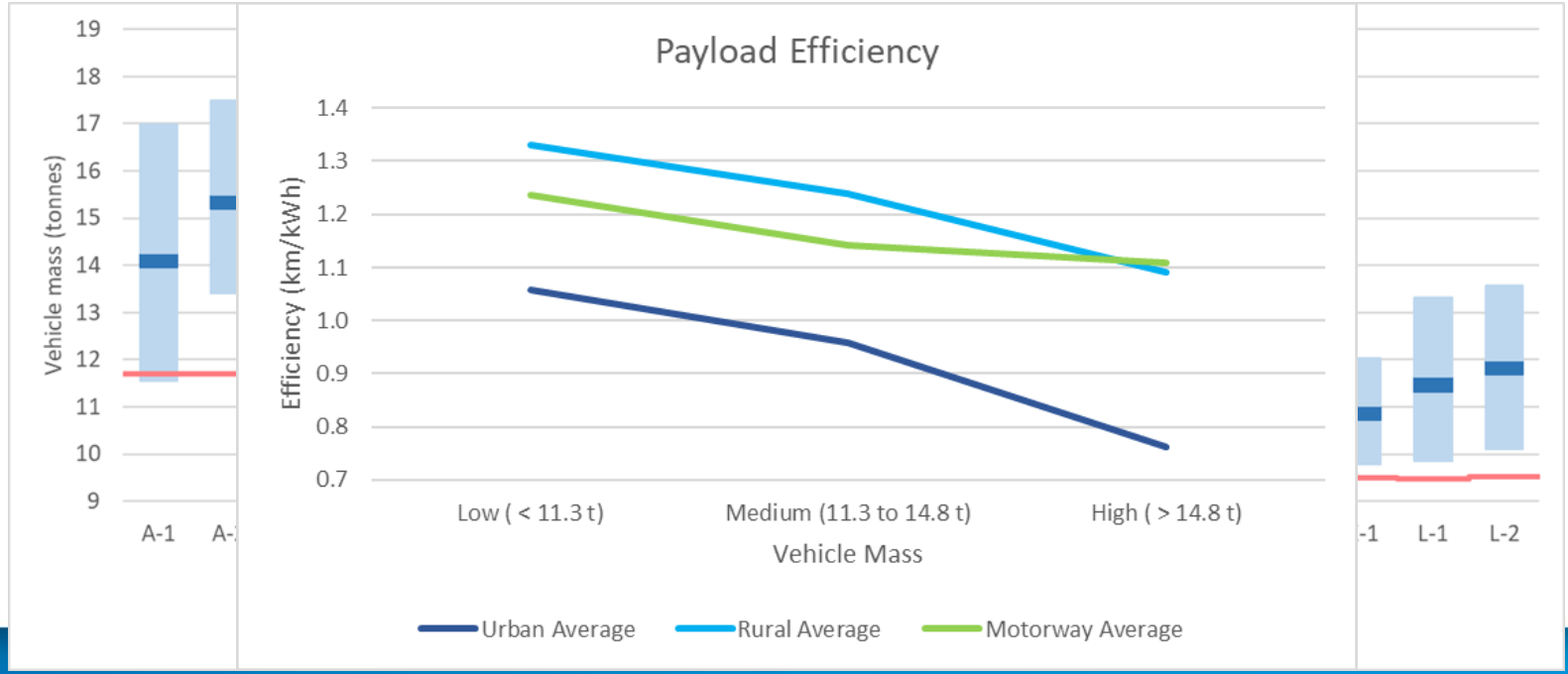
cenex

Temperature and Ancillaries



Payload

- Refrigerated vehicles are heavier

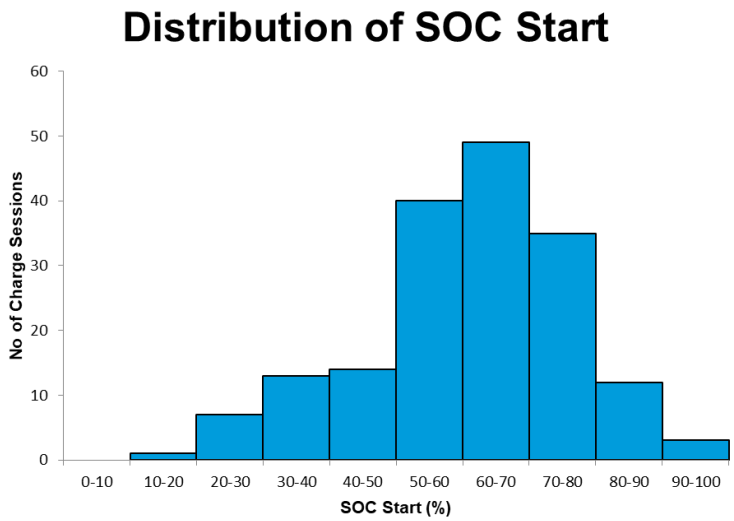


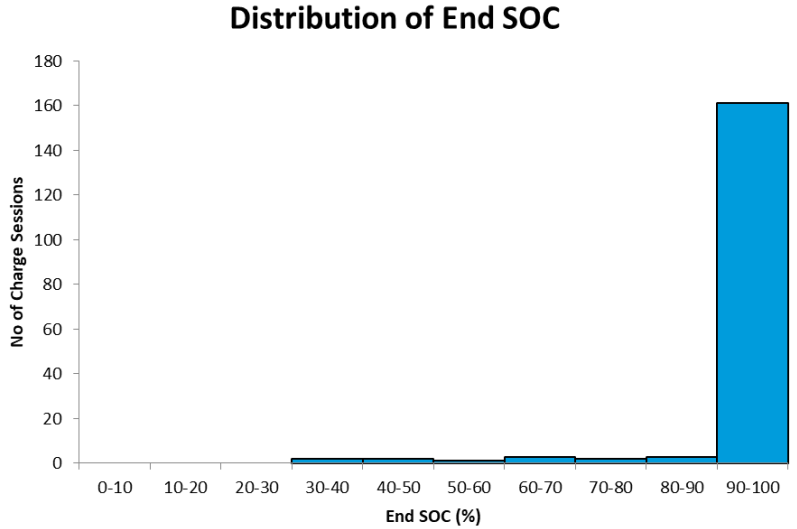
Transport | Energy Infrastructure | Knowledge & Enterprise

cenex

Charging Patterns

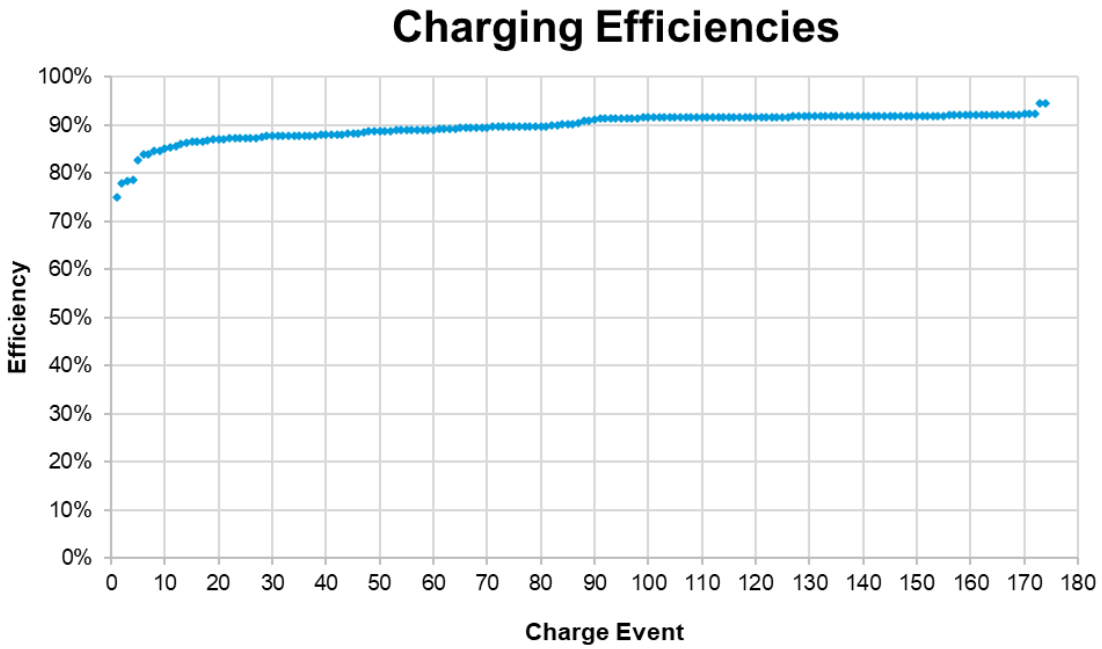
The battery is more than half full 80% of the time when the vehicle starts to charge.





And almost never finishes less than full.

Charging Efficiency



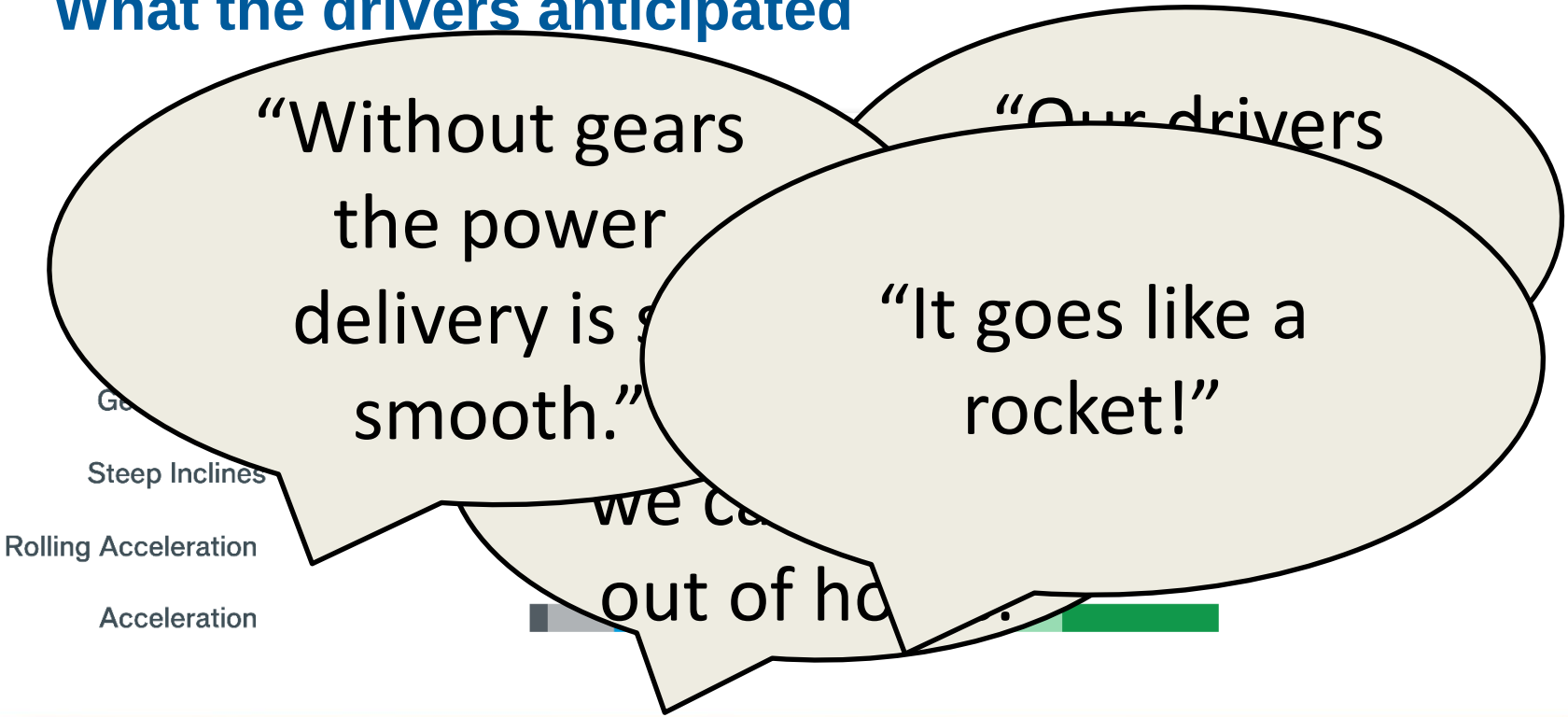
The efficiency of the on-board charger for 22kW fast charging is consistently around 90%.

Transport | Energy Infrastructure | Knowledge & Enterprise

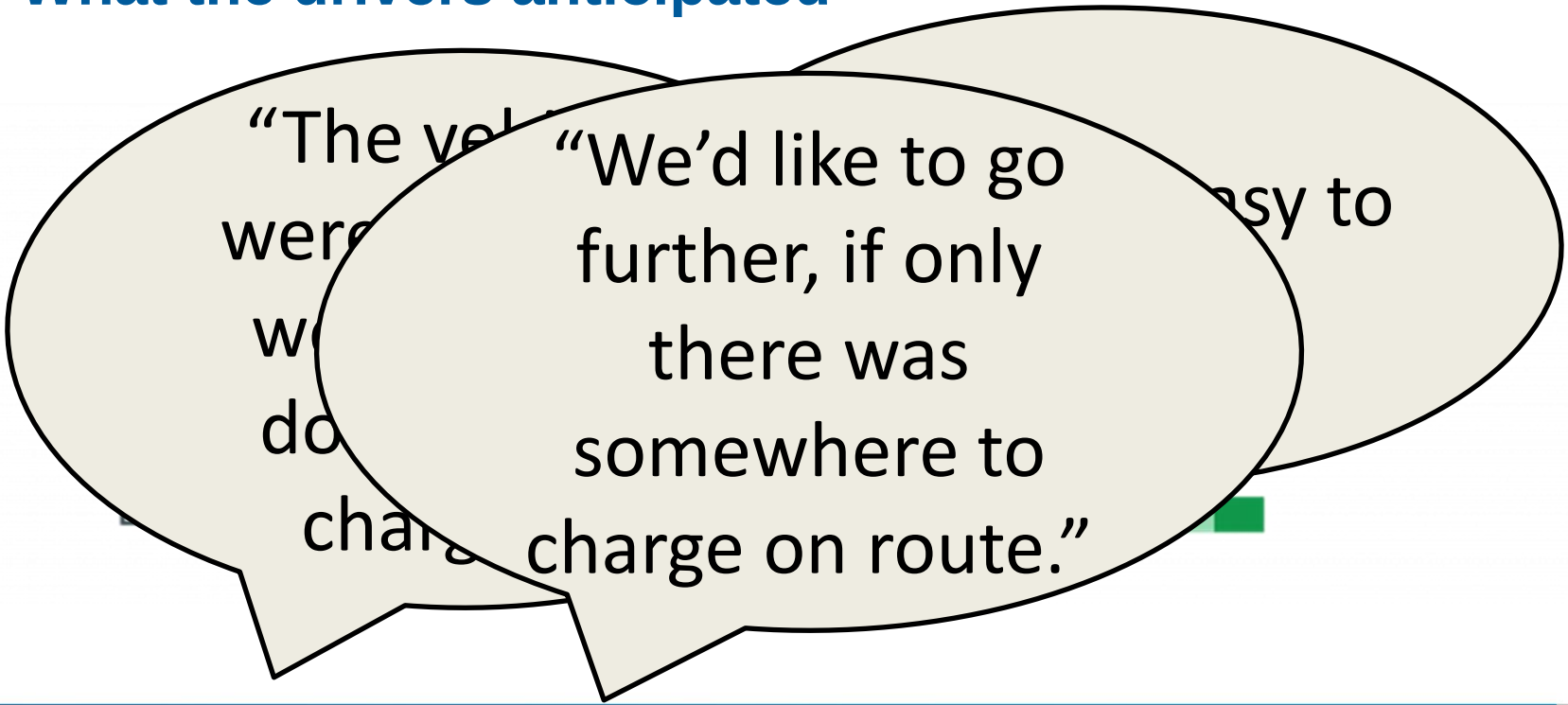
cenex

Driver Behaviour and Feedback

What the drivers anticipated



What the drivers anticipated



Transport | Energy Infrastructure | Knowledge & Enterprise

cenex

Thank you for listening

Tom Allerton

Senior Technical Specialist

tom.allerton@cenex.co.uk


Start the Future

PACCAR

Peterbilt

KENWORTH

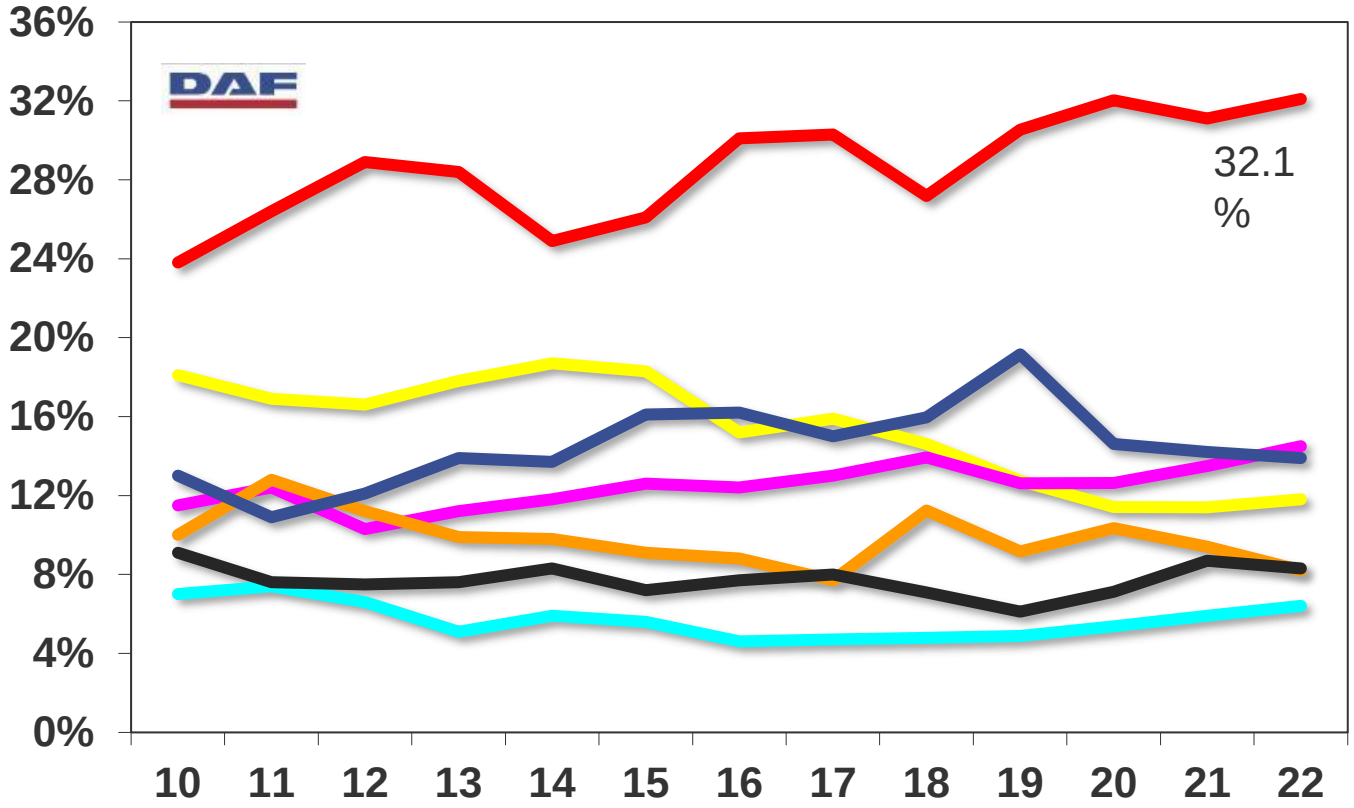
DAF

LEYLAND TRUCKS

A PACCAR COMPANY

MARKET SHARE UNITED KINGDOM

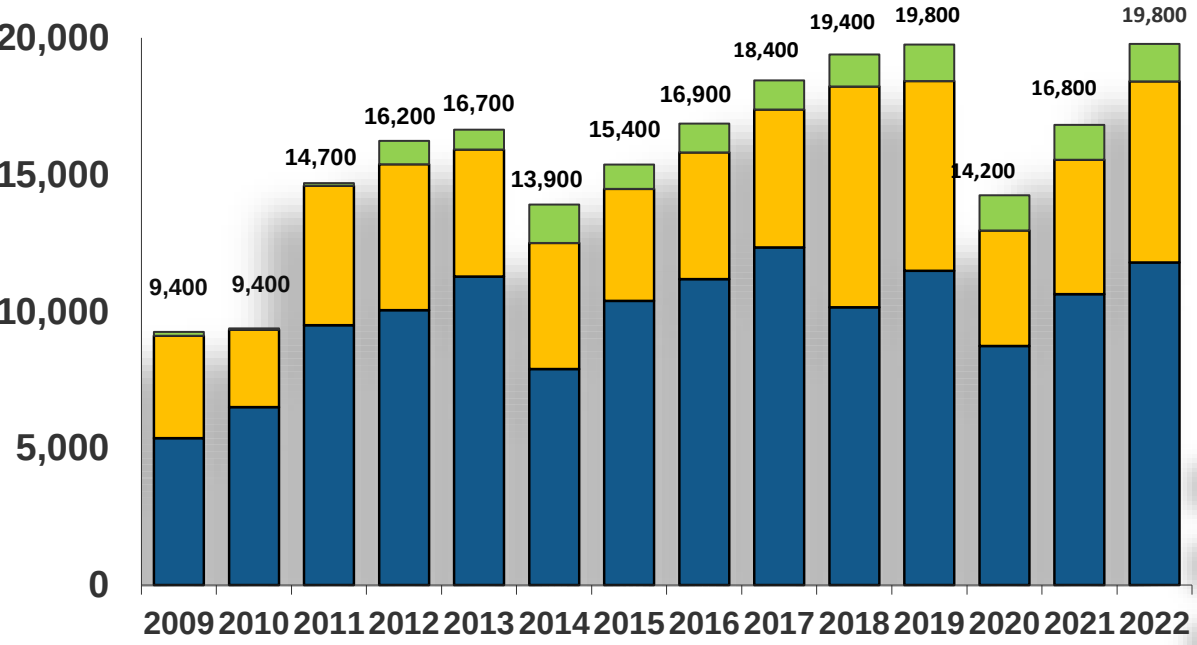
≥ 6T GVW



28 YEARS
UK MARKET LEADER

- DAF
- Competitor A
- Competitor B
- Competitor C
- Competitor D
- Competitor E
- Competitor F

LEYLAND TRUCKS VEHICLE PRODUCTION…



Medium-Duty Kit Export (CKD)

DAF Heavy-Duty CF/XD/XF/XG(+)

DAF Medium-Duty LF/XB

LEYLAND TRUCKS HISTORY

1896
Lancashire
Steam Motors
Company

1900's
First petrol
engine

1920
The Leyland
Zoo

1930's
Diesel engine
production

1964
Ergomatic
cab

1980
Roadtrain

1980
Leyland
Assembly
Plant

1987
Leyland merges
with DAF

LEYLAND DAF

1993 Leyland
Trucks
Management buy-
out

LEYLAND TRUCKS
A PACCAR COMPANY

1996/1998
PACCAR acquires
DAF and Leyland
Trucks

PACCAR

DAF

LEYLAND TRUCKS HISTORY

1896
Lancashire
Steam Motors
Company

1900's
First petrol
engine

1930's
Diesel engine
production

1931 Leyland Electric
Trolley Bus

1970's
Leyland
Electric Terrier

2000's
DAF LF Hybrid

2010
DAF LF BETR

2018 DAF LF
IAA-Exhibition

2021
DAF LF BEV
Series
Production

DAF ELECTRIC

XB ELECTRIC

12 t +

XD ELECTRIC

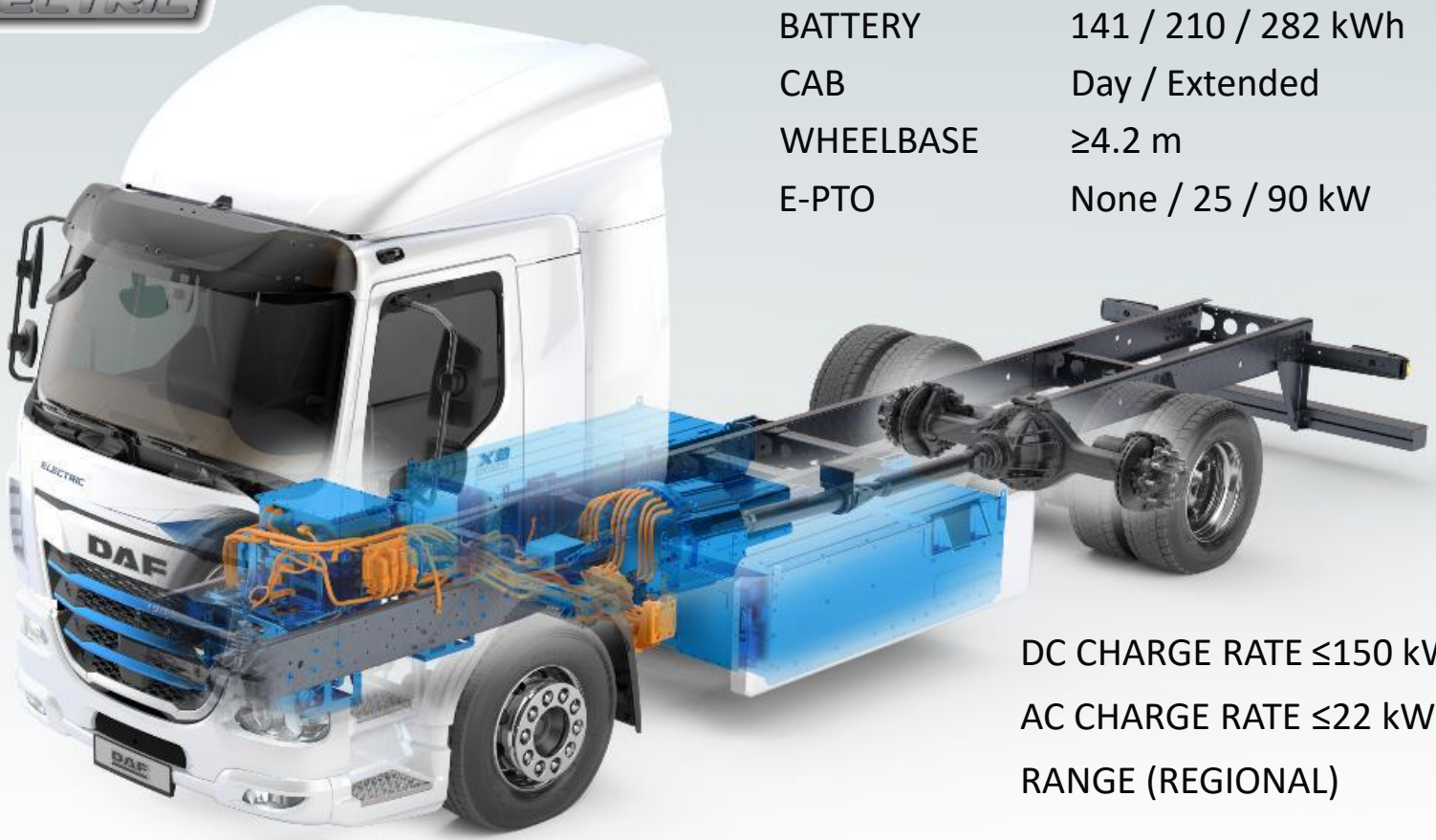
18 t +

XF ELECTRIC

26 t +

XB ELECTRIC

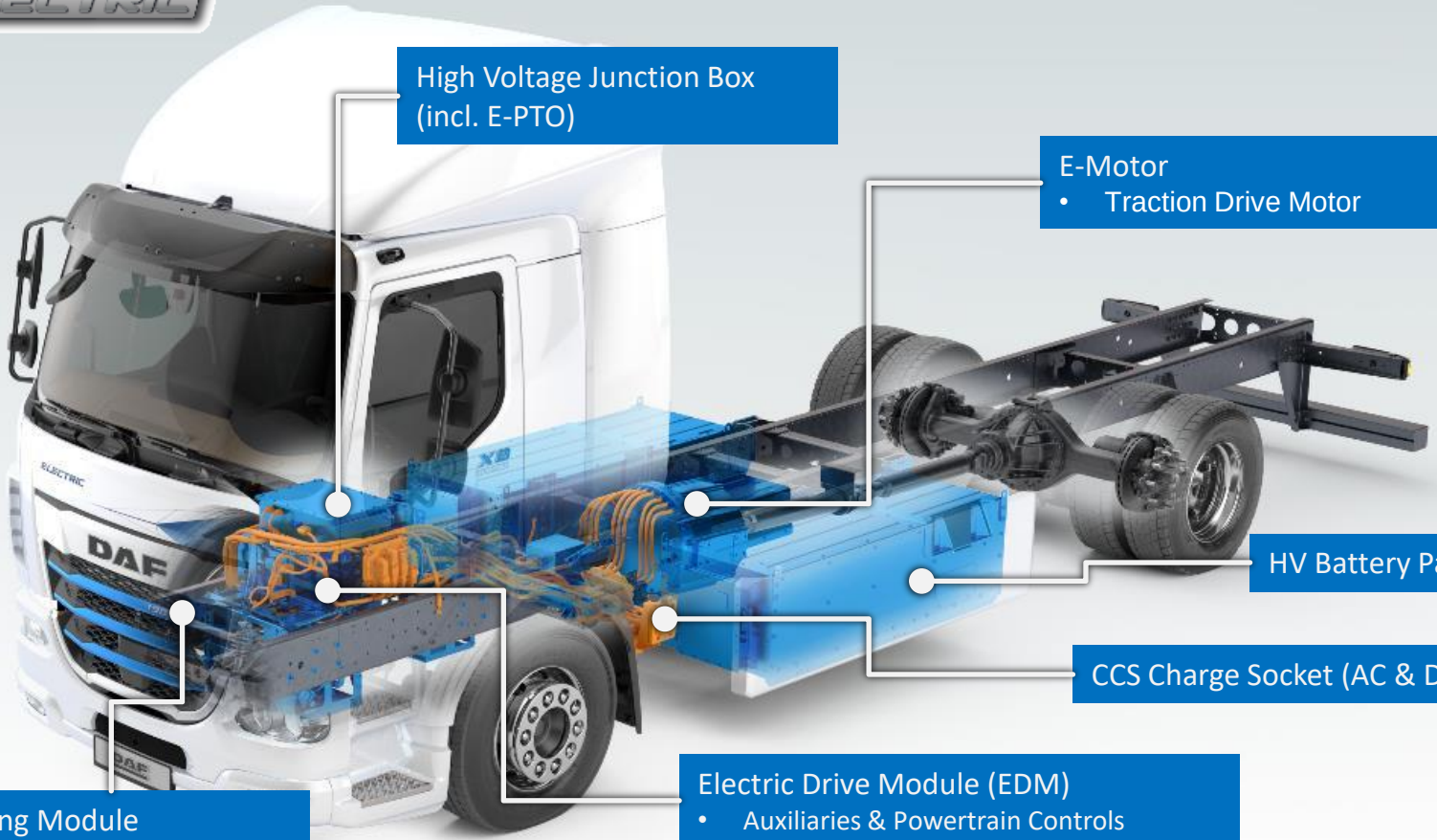
G.V.W.	12 / 16 / 19 tonne
E-MOTOR	120 / 190 kW
BATTERY	141 / 210 / 282 kWh
CAB	Day / Extended
WHEELBASE	≥4.2 m
E-PTO	None / 25 / 90 kW



DC CHARGE RATE ≤150 kW

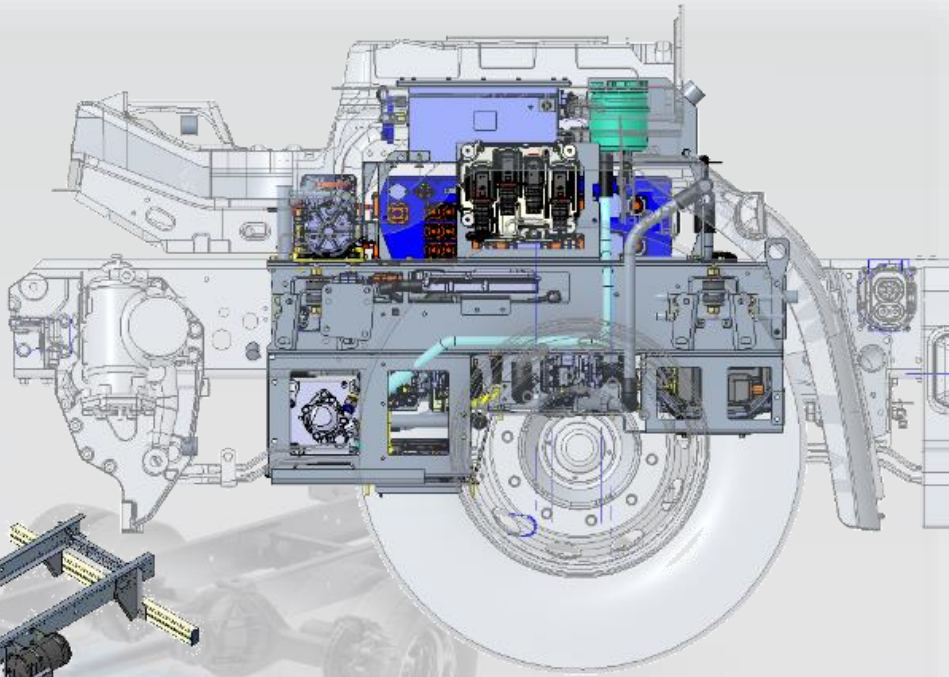
AC CHARGE RATE ≤22 kW

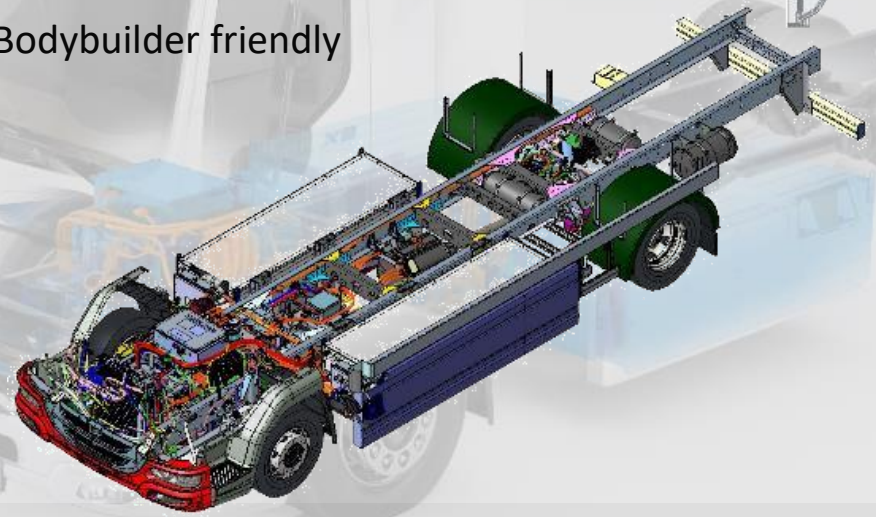
RANGE (REGIONAL) ≤350 km


High Voltage Junction Box
(incl. E-PTO)
E-Motor
• Traction Drive Motor
HV Battery Packs
CCS Charge Socket (AC & DC)
Electric Drive Module (EDM)
• Auxiliaries & Powertrain Controls
Cooling Module

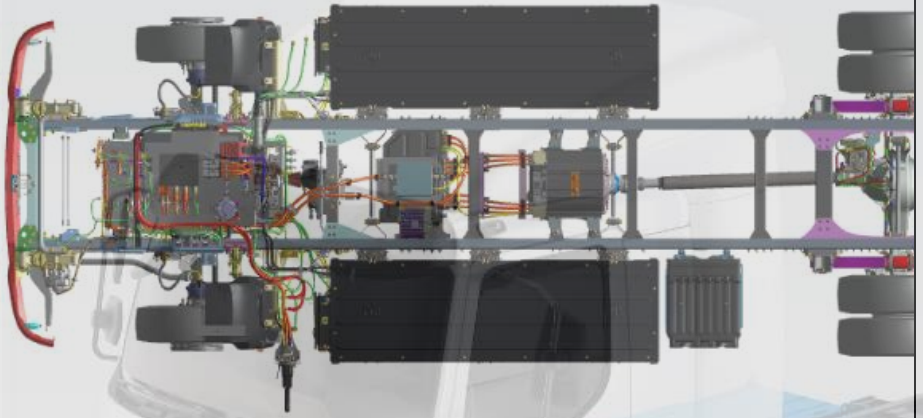
CHASSIS LAYOUT

- EDM with ICE Silhouette
- Drop in Modules
- Conventional Frame, Cab, Axles & Suspension
- Intuitional Layout (BEV / ICE)
- High Volume Production Line Build Quality
- Workshop / Bodybuilder friendly



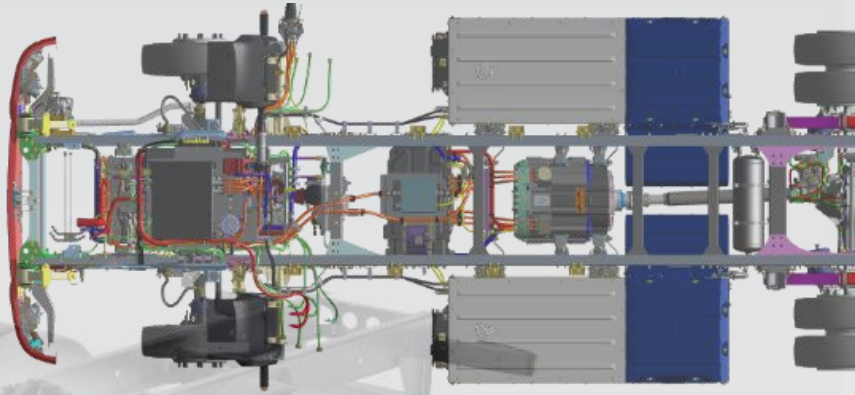


HV BATTERY| BASIC LAYOUT



- The H-Pack Battery
- 2 Battery Packs 282kWh

  or
- 1 Battery pack 141kWh



- The C-Pack Battery
- 2 Battery Packs 210kWh

XB NEW FEATURES

- Safety focus with Advanced Driver Assistance Systems
- Improved Direct Vision
- Restyled Exterior & Interior

XB DIGITAL INSTRUMENT PANEL


DAF

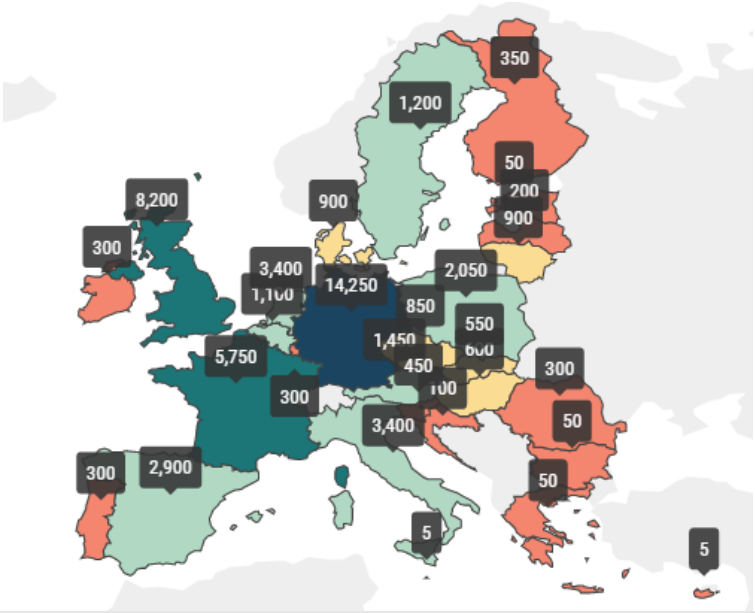

DAF


DAF

CHARGING INFRASTRUCTURE

Adam Bennett
EV & Sustainability Manager

MARKET EXPECTATIONS



Emission targets

55%

2030 Climate EU Target wants to reduce greenhouse gas emissions **by at least 55%.**

Specifically, greenhouse gas emissions from transport need to be reduced **by 90% by 2050.**

90%

Volume targets

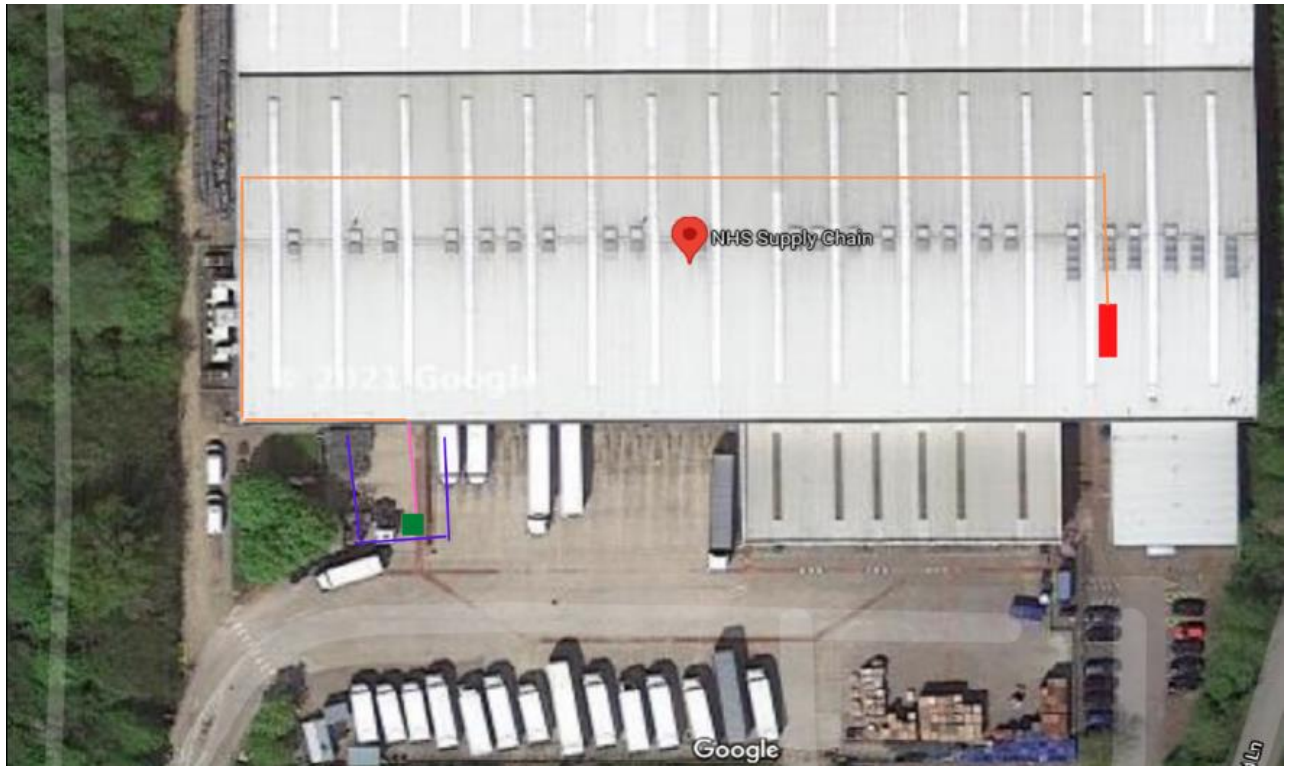
- Target EU & UK of **40K** electric medium / heavy-duty trucks by 2025, rising to **270K in 2030.**
- Target EU & UK of **15K public high power charging points by 2025**, rising **to 50K by 2030**. Additionally, 40K lower power public overnight chargers at truck parking.
- **Private charging infrastructure** at customer sites will be necessary to be cost competitive with ICE transport.

INFRASTRUCTURE

Learning opportunities:

- Site surveys
- Decision makers
- What is the preferred charger? Now and in the future
- What is the grid connection of site (kW) or “free” power availability?
- Where is the power connection is to be made
- Proposed place where the charger is to be installed
- Are there other infrastructural works that are required?
- Health & Safety / Site restrictions / one way systems / height restrictions
- Charging cable lengths
- Site power outages
- Distribution Network Operator local commitment
- Cost

SITE EXAMPLES



CHANGE PROCESS – DIESEL TO ELECTRIC

ANALYSE CURRENT ROUTES

BUSINESS CASE ANALYSIS

ENSURE CHARGING INFRASTRUCTURE

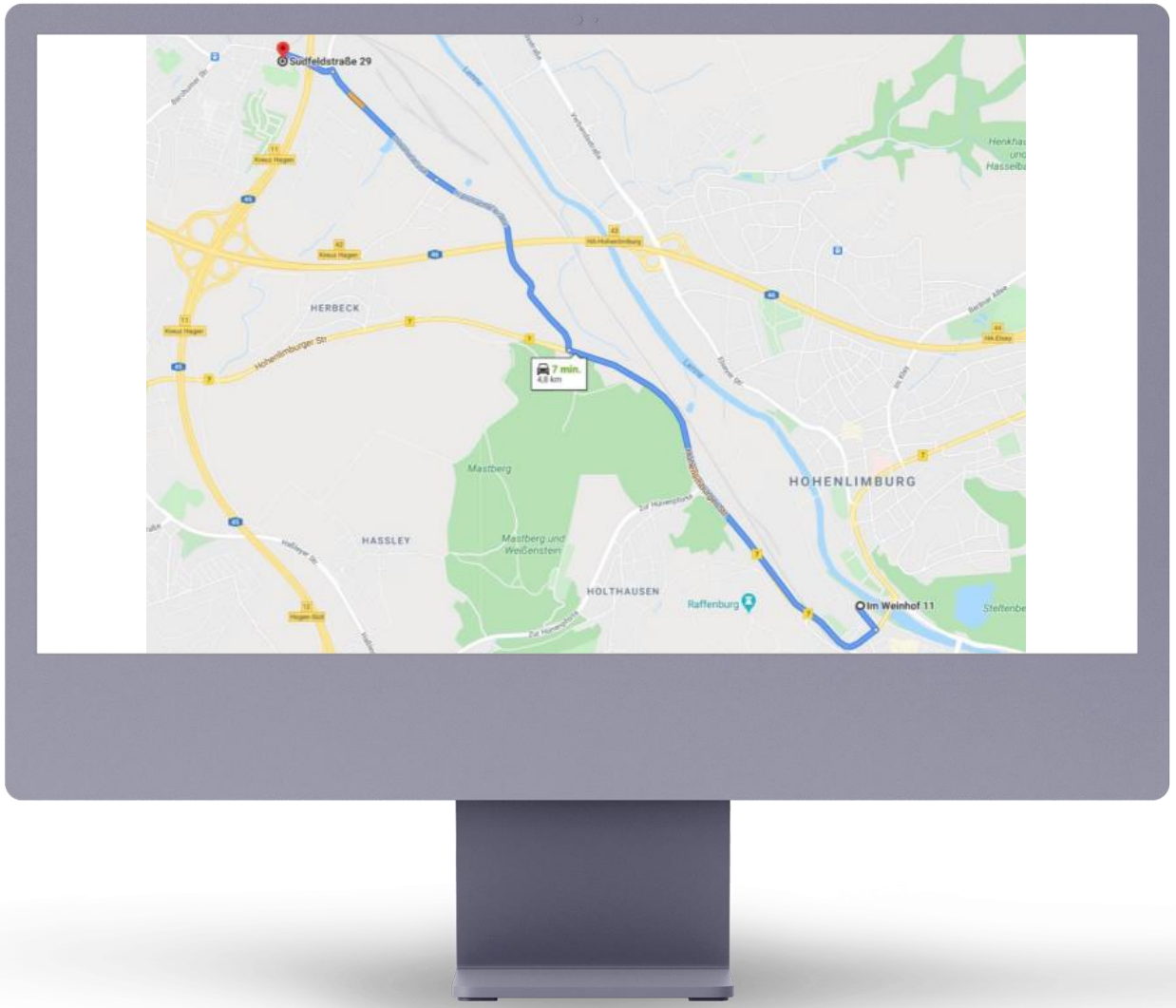
START ELECTRIC TRANSPORT

DAF – YOUR PARTNER FOR ELECTRIC TRANSPORT

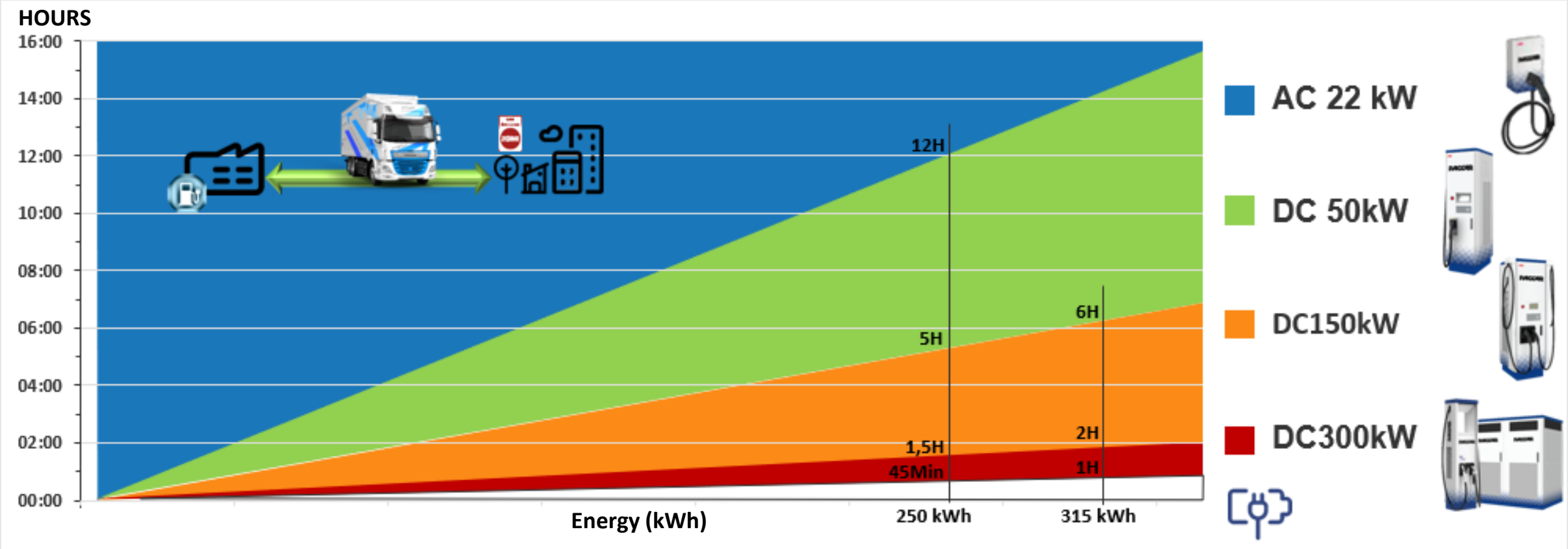
ROUTE ANALYSIS

Important operation inputs:

- Route data
- Vehicle weights
- PTO consumption (diesel)
- Possible charging times



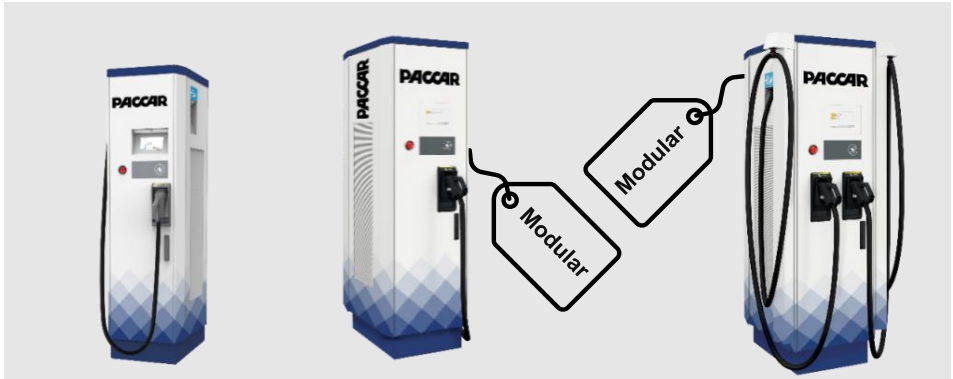
CHARGING STRATEGY



PACCAR charger portfolio

PacCharge AC20 (7, 11, 22kW)

PacMobile 20 – PacMobile 40X
(24kW – 40kW)



ChargeMax 50 - ChargeMax 180
(50kW - 180kW)

PowerChoice 150X - PowerChoice 360X
(150kW – 360kW)

CHARGER SERVICE

Charger Service Contract

1. 24/7 Remote Support
2. Local Technical Support
3. Supplier Specialist Support

24/7 service

- Spare Mobile Charger (Heliox Chargers)
- Over the Air Software Updates
- Guaranteed Flawless Charging DAF BEV
- Yearly (Preventive) Maintenance incl. Parts

LEX AUTOLEASE

EV RALLY 2023

THE CAPITAL CITY CHALLENGE

CARDIFF • LONDON • EDINBURGH • BELFAST • DUBLIN

A GREENFLEET EVENT

TEAM

DAF

cenex

LEX AUTOLEASE

ev RALLY 2023

THE CAPITAL CITY CHALLENGE

CARDIFF · LONDON · EDINBURGH · BELFAST · DUBLIN

A GREENFLEET EVENT

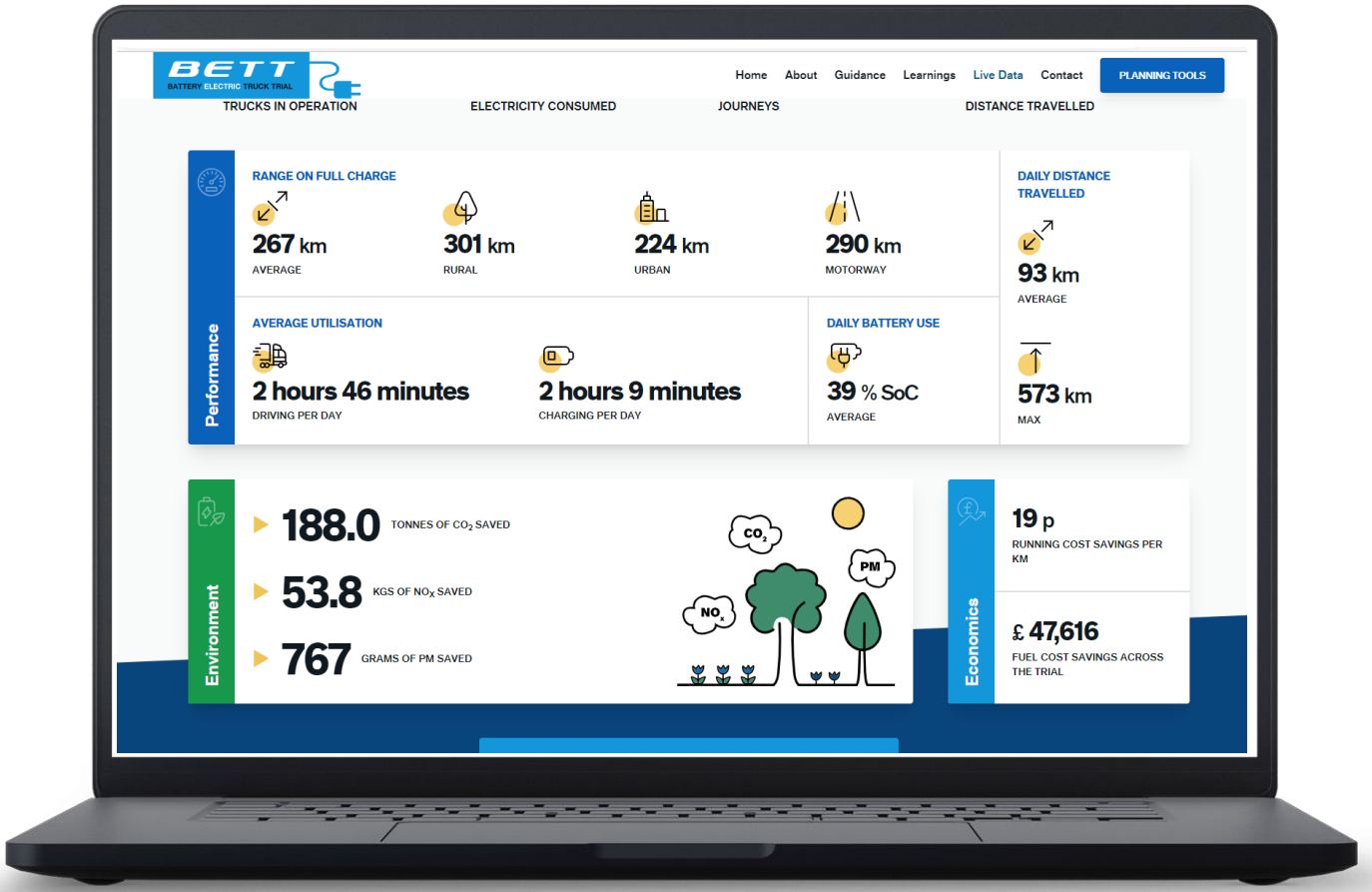
Follow the Rally

#evrally #netzero
#collaboration

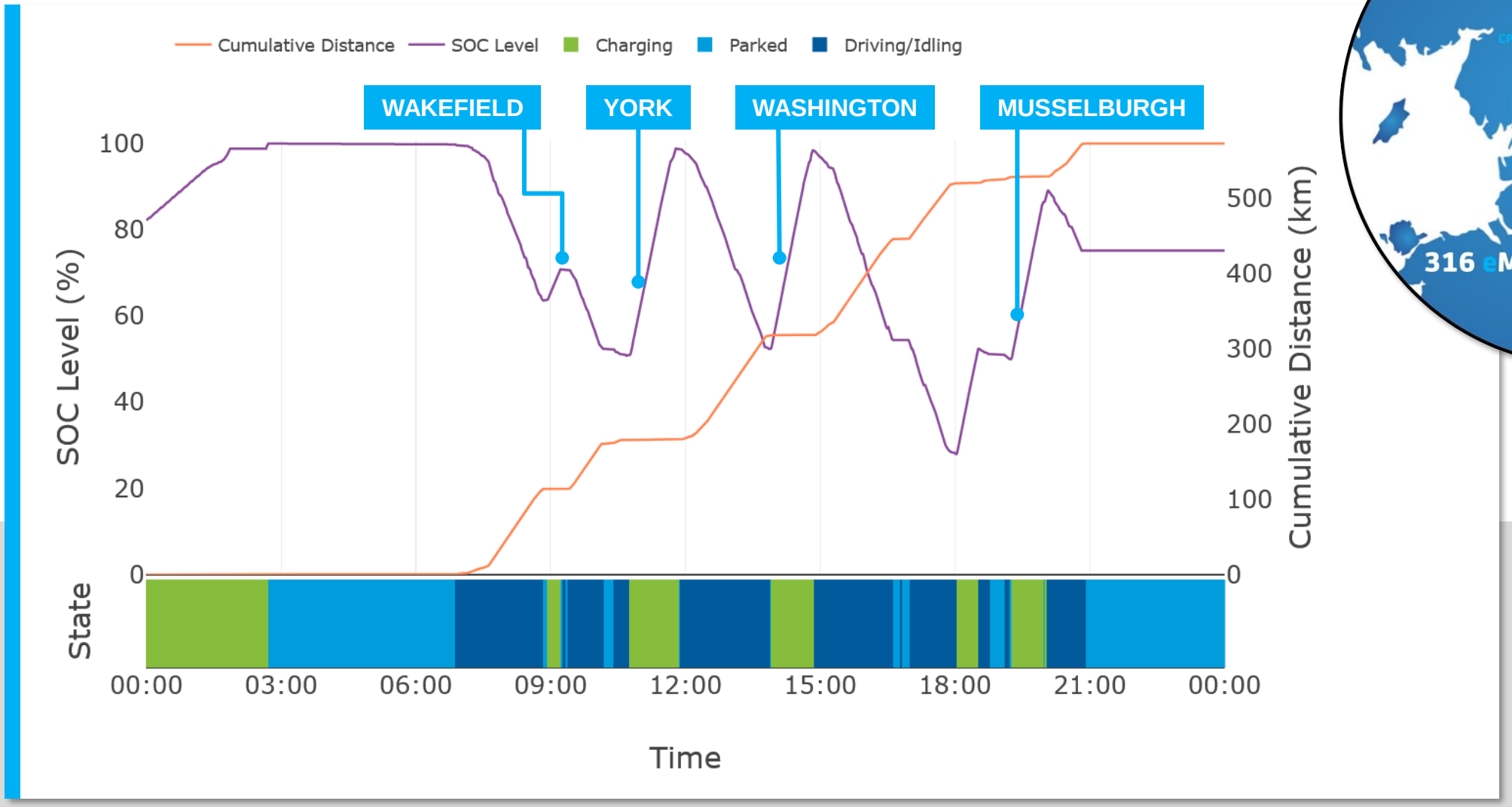
5 DAYS.... 1200 e-MILES.... 1 UNBELIEVABLE JOURNEY!

FIVE COUNTRIES & 1200 MILES IN FIVE DAYS

- **DAF LF Electric** 19t (9540 kg unladen)
- 250 kW nominal (370 kW peak)
- 282 kWh (254 kWh effective)
- Nominal range 280 km (174 miles)
- 150 kW DC or 22 kW AC charging

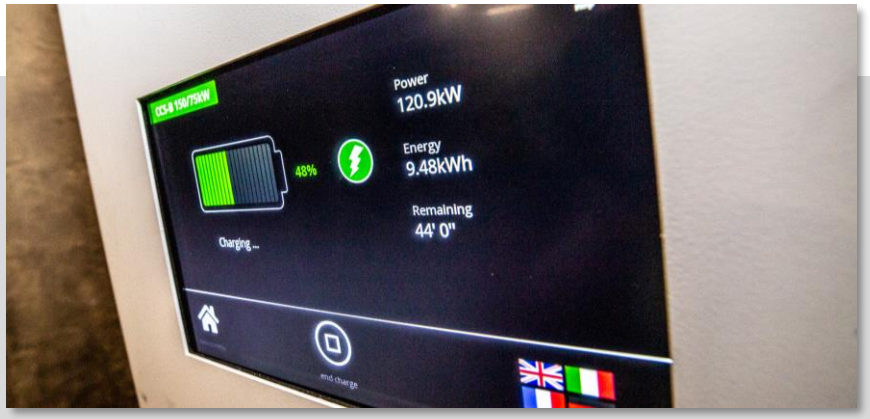


GRAZING STRATEGY



HYPERMILING

Day	Journey	Distance (km)	Total Energy Used (kWh)	Efficiency (km/kWh)
1	Cardiff - Nottingham	525.0	397	1.32
2	Nottingham - Edinburgh	572.8	443	1.29
3	Edinburgh- Belfast	227.6	183	1.24
4	Belfast - Newry	298.0	224	1.33
5	Newry - Dublin	314.6	263	1.20



HYPERMILING

Day	Journey	Distance (km)	Total Energy Used (kWh)	Efficiency (km/kWh)
1	Cardiff - Nottingham	525.0	397	1.32
2	Nottingham - Edinburgh	572.8	443	1.29
3	Edinburgh- Belfast	227.6	183	1.24
4	Belfast - Newry	298.0	224	1.33
5	Newry - Dublin	314.6	263	1.20

Equivalent to a maximum range of 333 km (207 miles)

A TIGHT **SQUEEZE**

Large Vehicle Charging

- Marked longer and wider bays
- Longer cables
- Canopy design
- Searchable

Charging made possible with thanks to fellow EV users

HGV FRIENDLY


BETT
evRALLY 2023
THE CAPITAL CITY CHALLENGE
COLLABORATION IN MOTION... UNBELIEVABLE!
DAF
PN22 FFU


COLLABORATION IN MOTION... UNBELIEVABLE!
DAF
PN22 FFU


BETT
TEAM
DAF
COLLABORATION IN MOTION... UNBELIEVABLE!
PN22 FFU


BETT
TEAM
DAF
cenex


BETT
BATTERY ELECTRIC TRUCK TRIAL
HELPING DELIVER ZERO EMISSION TRANSPORT
TEAM
DAF
cenex


BETT
TEAM
DAF
cenex


BETT
BATTERY ELECTRIC TRUCK TRIAL
GVRALLY
THE CAPITAL CITY CHALLENGE
TEAM
DAF
cenex
DAF
PN22 FFU


GVRALLY
DAF
PN22 FFU


EVRALLY
THE CAPITAL CITY CHALLENGE


EVRALLY2023
THE CAPITAL CITY CHALLENGE
COLLABORATION IN MOTION... UNBELIEVABLE!
DAF
PN22 FFU
THE FORTH ROAD BRIDGE


Stena Line


COLLABORATION IN MOTION... UNBELIEVABLE!
DAF
PN22 FFU
Stena Line
EXIT
Thank you for travelling
Stena Line


EXIT
Thank you for travelling
Stena Line


BETT
BATTERY ELECTRIC TRUCK TRIAL
HELPING DELIVER ZERO EMISSION TRANSPORT
evRALLY
THE CAPITAL CITY
TEAM
DAF
cenex
COLLABORATION IN MOTION... UNBELIEVABLE!
DAF
PK22 FFU


BETT
BATTERY ELECTRIC TRUCK TRIAL
HELPING DELIVER ZERO EMISSION TRANSPORT
TEAM
DAF
cenex
COLLABORATION IN MOTION... UNBELIEVABLE!


BETT
COLLABORATION IN MOTION... UNBELIEVABLE!
TEAM
DAF
PN22 FFU
The Giant's Barn
Cafe


BETT
TEAM
DAF


The Giant's Barn
Cafe


BETT
BATTERY ELECTRIC TRUCK TRIAL
evRALLY2023
THE CAPITAL CITY CHALLENGE
TEAM
DAF
CADDS
COLLABORATION IN MOTION. UNBELIEVABLE!
DAF


HARRIS
LEX AUTOLEASE
evRALLY
THE CAPITAL CITY CHALLENGE
#evrally #collaboration #netzero

LEX AUTOLEASE

evRALLY2023

THE CAPITAL CITY CHALLENGE

CARDIFF • LONDON • EDINBURGH • BELFAST • DUBLIN

A GREENFLEET EVENT