Transport | Energy Infrastructure | Knowledge & Enterprise

cenex

BETT Quarterly Report

Trial Q4: January – March 2023

Cenex

Transport Team

Transport | Energy Infrastructure | Knowledge & Enterprise

Document Control

	Name and Job Title	Organisation
Prepared for:	Steven Birch, Continuous Improvement Manager	Leyland Trucks
Prepared by:	Tom Price, Data Analyst	Cenex
Approved by:	Tom Allerton and Victor Lejona, Senior Technical Specialists	Cenex

Revision No.	Details	Date Issued
1	Initial Draft	24-05-2023
2	Minor revisions	09-06-2023

Company Details

Cenex
Holywell Building
Holywell Park
Ashby Road
Loughborough
Leicestershire
LE11 3UZ

Registered in England No. 5371158

Tel: 01509 642 500

Terms and Conditions

About BETT: the Battery Electric Truck Trial

In June 2021, DAF were awarded funding under the SBRI ZE Road Freight Competition to deploy and undertake research on the performance of 20 DAF LF Battery Electric Trucks.

Cenex, a non-profit research & consultancy organisation focused on low emission transport & associated energy infrastructure, partnered with DAF trucks to lead the study aspects of the research.

A key focus of the research and study aspect is to develop learning materials to promote and educate fleet owners about electric trucks to help remove barriers to adoption. This report informs on data insights from the fourth quarter of the trial (January to March 2023).

Contents

Best of BETT this Quarter

387 km travelled in one day*

(Vehicle C-1, 14-03-2023, 162% battery used)

396 kWh used in one day*

(Vehicle C-1, 14-03-2023, 162% battery used)

07:50 hours worked** in one day*

(Vehicle C-1, 14-03-2023, 162% battery used)

367 kWh charged in one day

(Vehicle B-1, 07-03-2023, using a rapid charger)

* The vehicle charged during the day using a rapid charger
** Time worked includes time spent driving and idling (e.g. stopped at traffic lights), but not loading and unloading.

Summary of the Quarter

Summary Stats	Q1 (Apr-Jun 2022)	Q2 (Jul-Sep 2022)	Q3 (Oct-Dec 2022)	Q4 (Jan-Mar 2023)	Total
Active Trucks	12	18	19	18	20
Total Distance	15,911 km	53,240 km	55,507 km	31,591 km	156,249 km
Total Energy	13,609 kWh	47,091 kWh	57,833 kWh	38,309 kWh	156,842 kWh
Total Number of Journeys	697	2,470	3,222	2,150	8,539
Total Emissions Savings*	11.5 tCO_2	38.7 tCO_2	40.7 tCO_2	23.4 tCO_2	114.3 tCO_2
Real World Range					
Average	296 km	288 km	253 km	241 km	267 km
Urban	253 km	239 km	214 km	206 km	225 km
Rural	342 km	315 km	284 km	274 km	296 km
Motorway	299 km	300 km	272 km	260 km	282 km

* WTW CO2e compared to a diesel equivalent truck.

Vehicle Activity Summary

This table summarises the distance travelled and number of days driven for each vehicle this quarter.

Due to data logging issues no data was received from C-2 this quarter, despite being available in previous quarters.

Compared to the third and second quarters, vehicles have generally not travelled as far, and driven on fewer days.

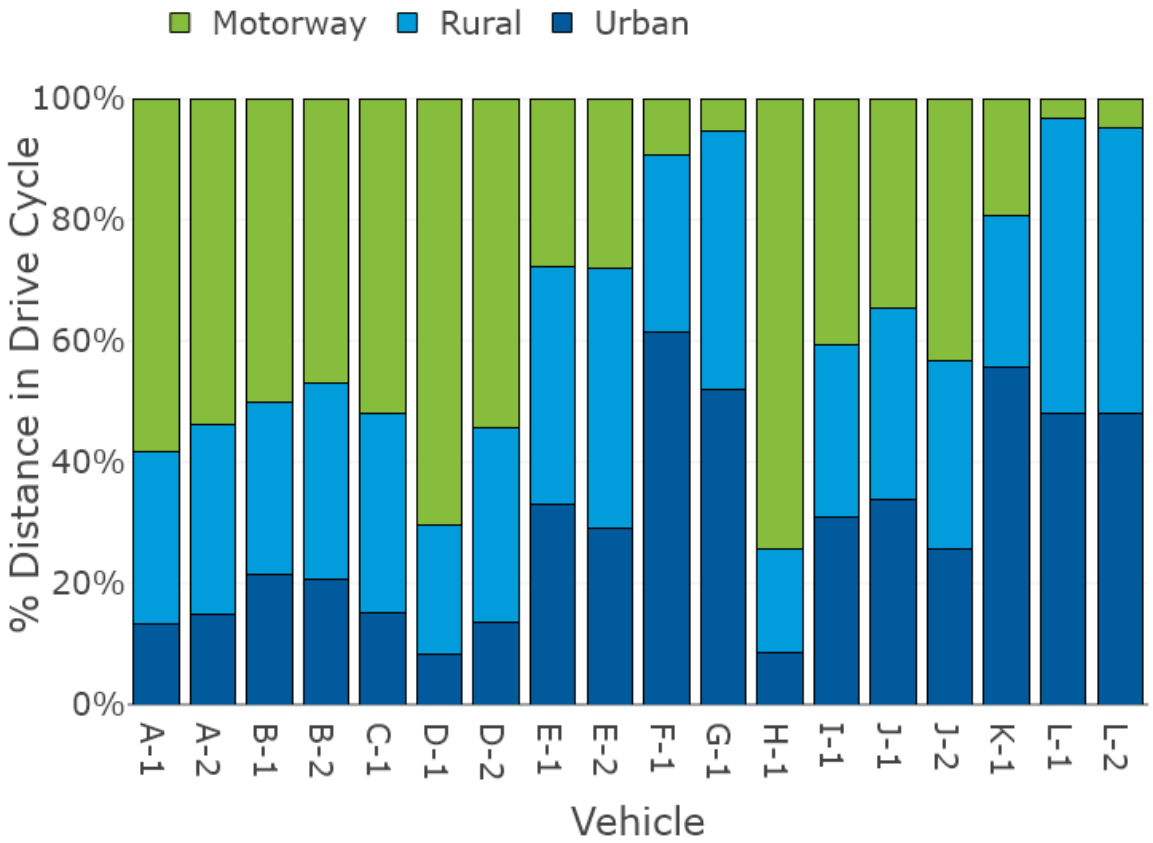
Fleet	Active/Expected	Vehicle	Distance Travelled (km)	Days Driven
A	2/2	A-1	666	21
		A-2	928	29
B	2/2	B-1	2,138	34
		B-2	3,241	45
C	1/2	C-1	5,304	46
D	2/2	D-1	744	18
		D-2	3,116	43
E	2/2	E-1	1,353	30
		E-2	2,257	30
F	1/1	F-1	237	12
G	1/1	G-1	2,274	42
H	1/2	H-1	2,806	30
I	1/1	I-1	962	32
J	2/2	J-1	1,100	51
		J-2	1,551	48
K	1/1	K-1	134	10
L	2/2	L-1	1,031	29
		L-2	1,749	41
Total	**18/20**		**31,591**	**591**

Drive Cycle

The drive cycles shown on the right describe the type of driving the vehicles exhibit. It is not based on geo-location, but on speed and acceleration statistics. For example, motorway is fast and consistent, whereas urban has more stops and starts.

Compared to Q3 there has been more urban and rural driving. There has been a decrease in motorway driving, but this is mostly due to the missing data from C-2, which made up one fifth of motorway driving last quarter.

G-1, L-1, L-2 and F-1 are notable for having almost no motorway driving. These vehicles are classified as mostly urban and rural because they tend to drive in city centres, which have lower speeds and more stops and starts.



The average for all vehicles is:

Urban 25% | Rural 33% | Motorway 42%

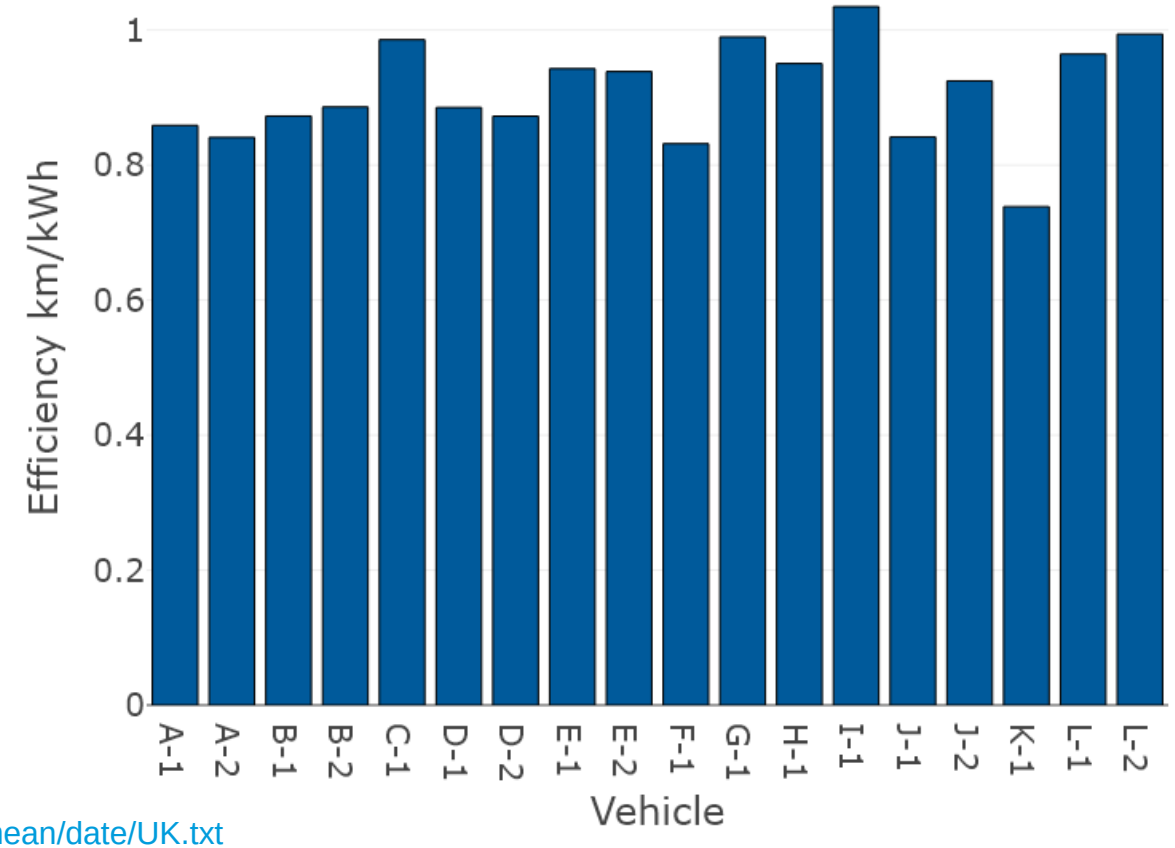
Energy Efficiency

The energy efficiency of the trucks across all drive cycles ranges between **0.74** and **1.03 km/kWh**.

With a 250 kWh battery, that translates to a real-world range of between **185 km** and **257 km**.

The average real-world range observed during the trial this quarter is **241 km**.

Energy efficiency is lower this quarter than in previous quarters. This is due to increased cab heater usage, and because all vehicles, both battery electric and combustion engine, tend to have lower efficiency in cold weather. This quarter had the lowest average ambient temperature in the trial, with an average of 5.3°C.*



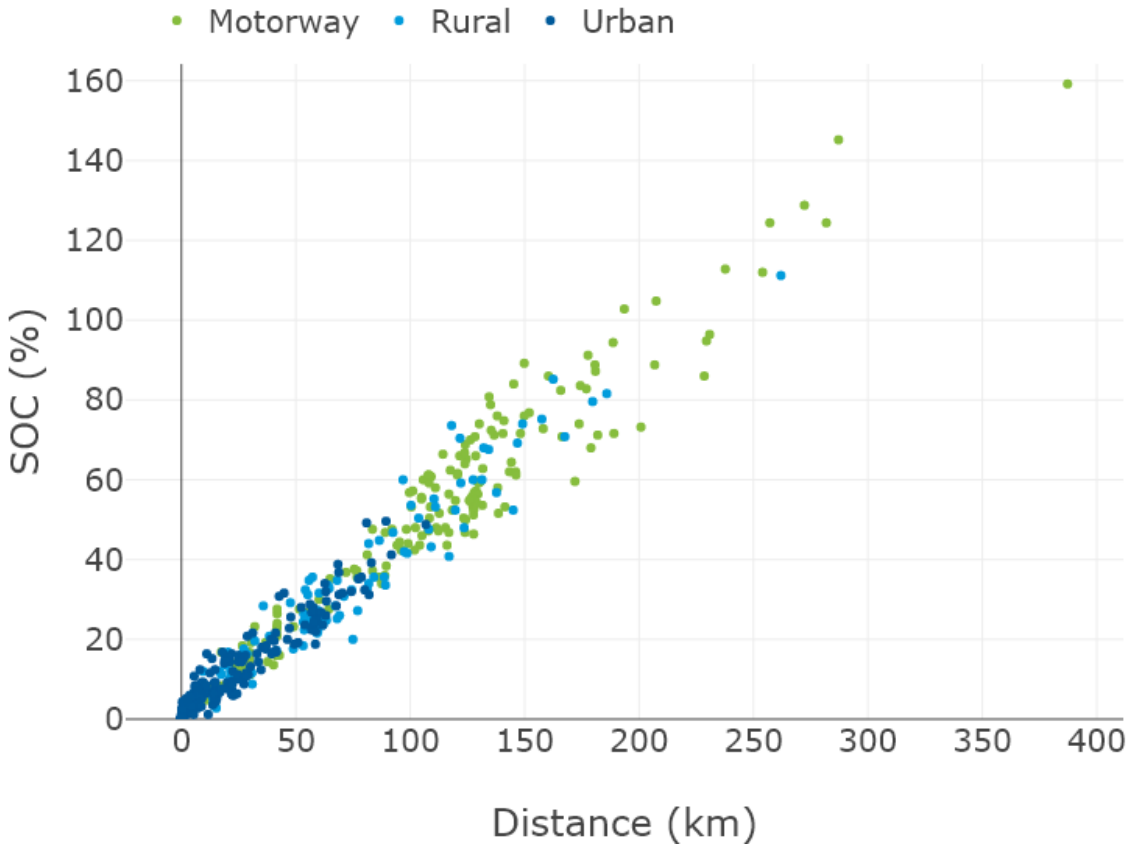
* https://www.metoffice.gov.uk/pub/data/weather/uk/climate/datasets/Tmean/date/UK.txt

Daily Distance vs Battery State of Charge (SOC)

This graph shows how far vehicles travelled in a day, and how much battery state of charge (SOC) was used*.

Days are colour coded by which drive cycle they mostly drove.

Many vehicles have continued to travel well beyond their range thanks to rapid charging during the day, with a peak of **387 km**.



* Only takes into account the energy used while driving or idling.

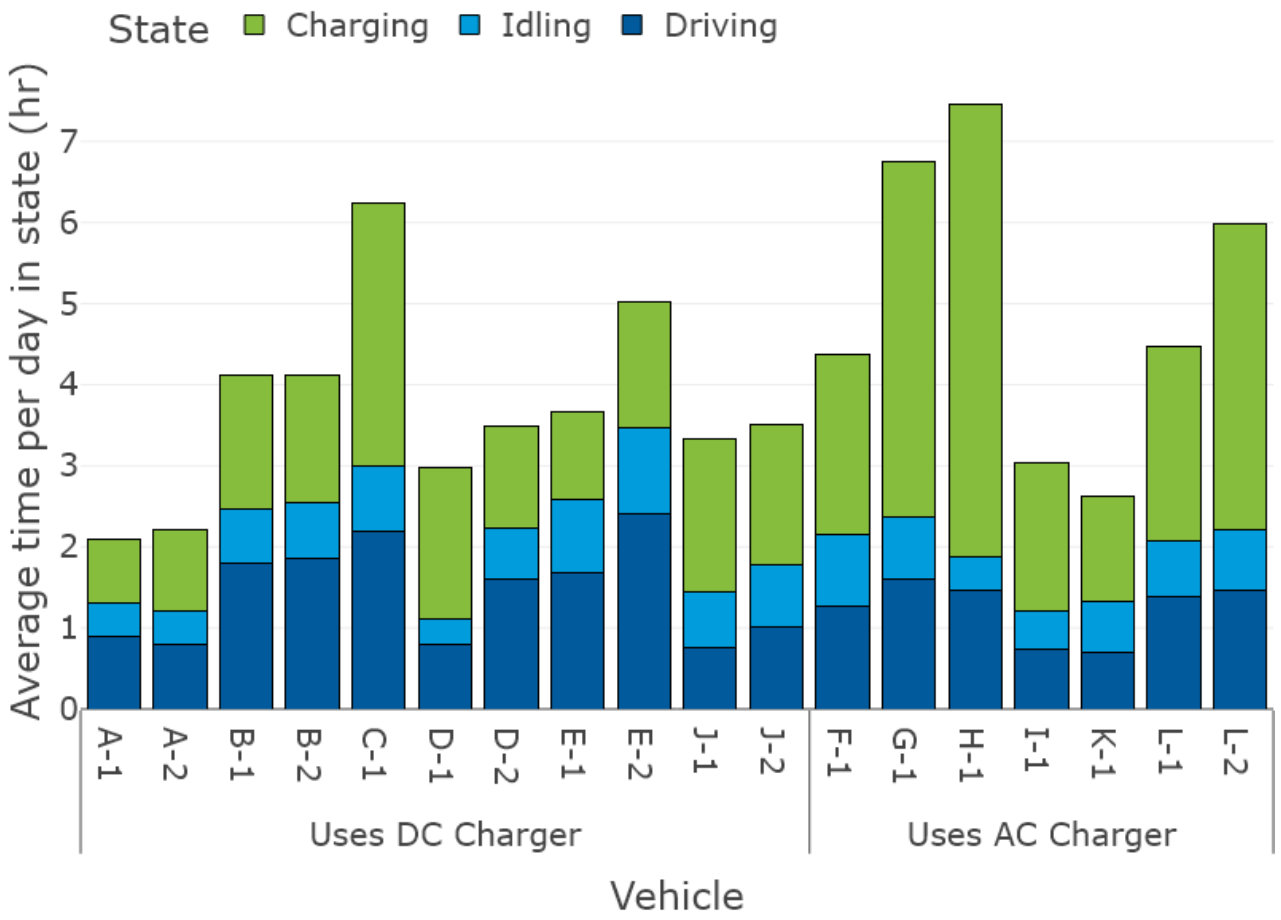
State Duration

A vehicle is in one of four states: driving, charging, idling (e.g., at traffic lights) and parked.

The graph to the right shows how long vehicles are in each state*, except for parked, which is the remainder. Note that 'parked' can also include loading and unloading cargo.

In Q4 the time to charge a vehicle compared to time spent driving has increased slightly since Q3. This is due to lower vehicle efficiencies. Vehicles using rapid charges spend slightly more time driving than charging (117%) while those using slower AC chargers spend more than double the driving time charging.

Quarter	Charging time as percentage of driving time	
	AC (fast)	DC (rapid)
Q2	178%	76%
Q3	233%	92%
Q4	266%	117%



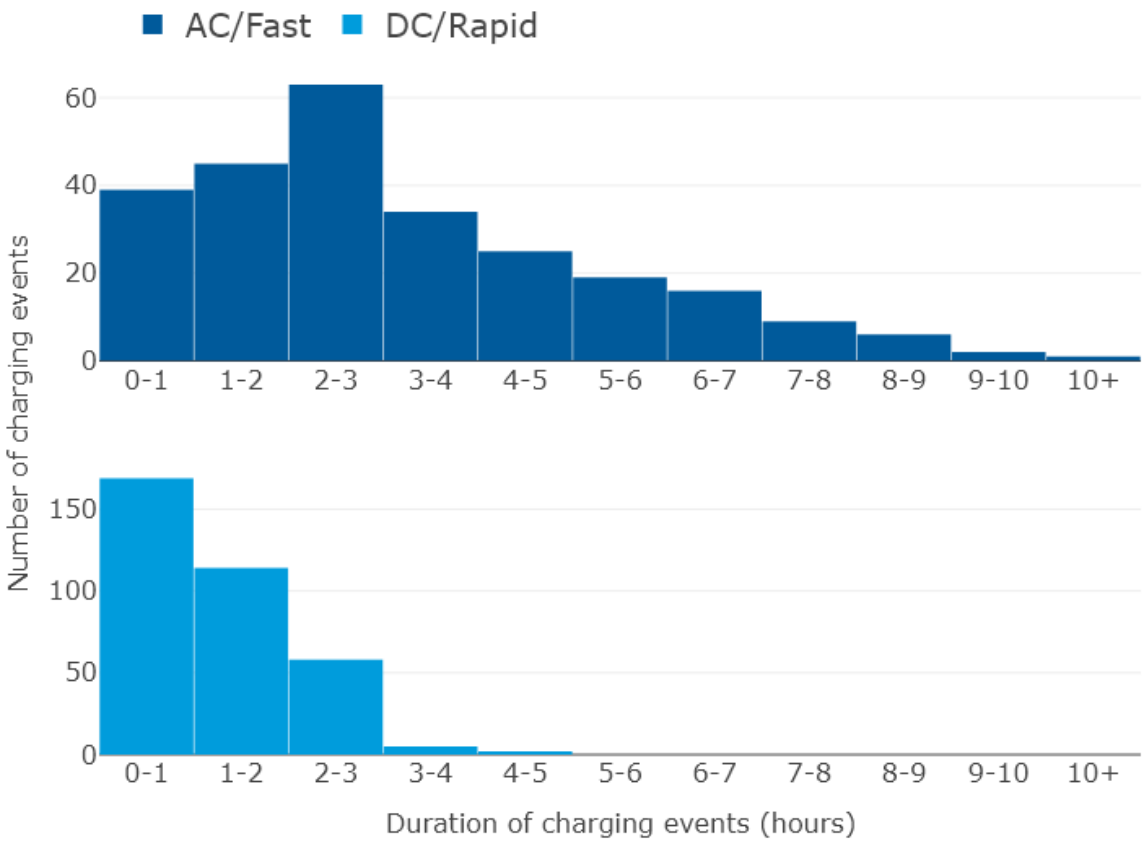
* Only includes days when vehicle is in use (driving or charging) for more than 20 minutes.

Charging Duration

This graph shows how long vehicles spend charging using AC fast (22 kW) or DC rapid (150 kW) chargepoints.*

AC charging is used both for top-up charging and overnight charging. There is a peak at **2-3 hours** for top-up charging, with longer sessions used for full overnight charges.

DC rapid charging sessions tend to take less than **2 hours**.



* Only charging sessions which last longer than 5 minutes are included.

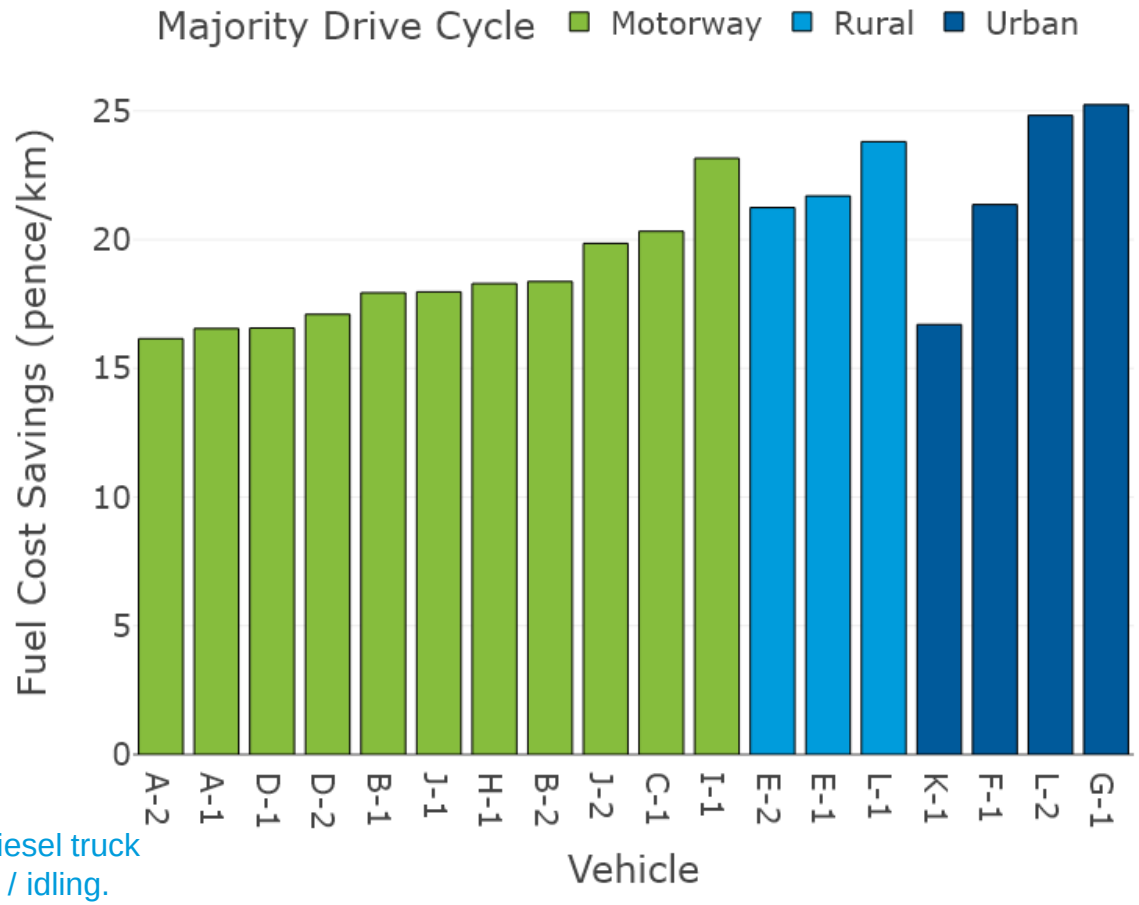
Fuel Savings

This graph shows the average fuel savings per km for each vehicle across the quarter*.

The average fuel savings range from 16p to 25p per km.

The fuel savings for a vehicle driving an annual distance of 50,000 km** would be between **£8,000** and **£12,500 per year**.

Fuel savings have decreased slightly this quarter due to colder weather causing a decrease in vehicle efficiency.

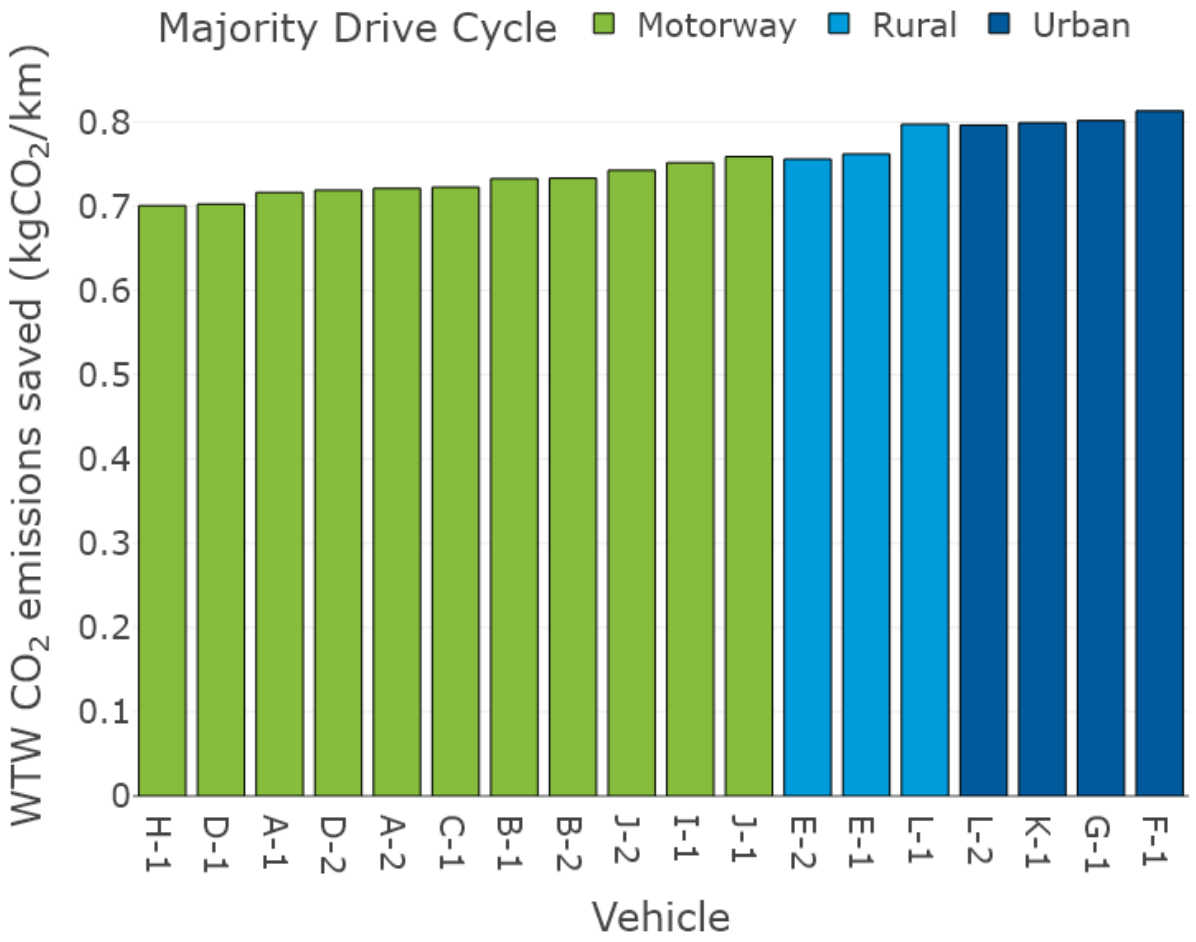


*These figures are generated using £1.90 p/l for diesel on an equivalent diesel truck and £0.23 per kWh for electricity. Figures only include energy from driving / idling. The prices used have been maintained to provide consistency with previous reports.
**Average annual distance in UK for 17-25t rigid trucks (source: DfT)

Emissions Savings

Emissions savings are calculated as the reduction in CO_2 emitted from 'Well to Wheel' (WTW), which includes the whole life cycle of the fuel/electricity from extraction/production/generation through to use in the vehicle.

Emissions saved range from **701 to 813 gCO_2/km**. The total WTW CO_2 saved in the fourth quarter of the trial was **23.4 tCO_2.**



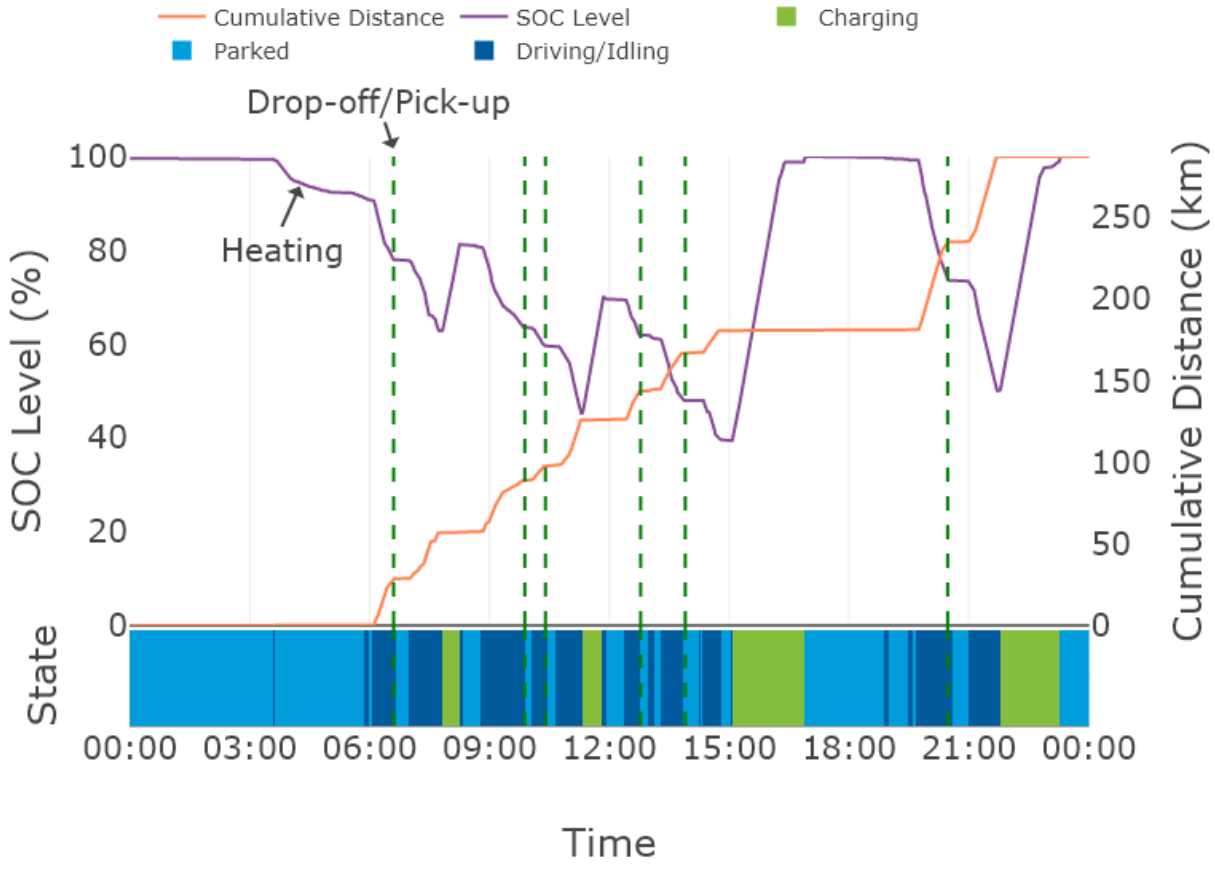
Case Study – Top-up Charging

This case study shows how to best use a temperature controlled electric truck by charging the vehicle between drop-offs/pickups.

For the first 2 and a half hours of the day the vehicle's cargo area is brought to temperature and loaded with goods, using 18kWh of energy. The ambient temperature at this time was about 3 °C and the truck attempts to maintain a temperature of 20 °C, so most of this energy would be used to heat the truck.

Throughout the day the truck makes 6 drop-offs/pickups (shown by the dashed lines) with 3 top-up charges in between.

Using top-up charging when returning to base allows this vehicle to comfortably complete its shift, travelling more than 250 km with the SOC dropping no lower than 39%.



Glossary of Terms

Acronym/Term	Definition
SOC	State of Charge
WTW	Well to Wheel
Urban	Many stops and starts
Rural	Steady continuous speed
Motorway	Higher continuous speed
BETT	Battery Electric Truck Trial
ZE	Zero Emission

Transport

Energy Infrastructure

Knowledge & Enterprise

cenex

To keep up to date with the trial, visit bett.cenex.co.uk

Cenex

Transport Team