Transport | Energy Infrastructure | Knowledge & Enterprise

cenex

BETT Quarterly Report
Trial Q3: October – December 2022

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	Final release	28/02/2023

Company Details

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

Registered in England No. 5371158

Tel: 01509 642 500

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 third quarter of the trial (October to December 2022).

Contents

Best of BETT this Quarter

453 km travelled in one day*

(Vehicle C-1, 22-11-2022, 189% battery used)

460 kWh used in one day*

(Vehicle C-1, 22-11-2022, 189% battery used)

08:58 hours worked** in one day*

(Vehicle C-1, 04-10-2022, 118% battery used)

455 kWh charged in one day

(Vehicle B-2, 02-11-2022, 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)	Total
Active Trucks	12	18	19	19
Total Distance	15,911 km	53,240 km	55,507 km	124,658 km
Total Energy	13,609 kWh	47,091 kWh	57,833 kWh	118,533 kWh
Total Number of Journeys	697	2,470	3,222	6,389
Total Emissions Savings*	11.5 tCO_2	38.7 tCO_2	40.7 tCO_2	90.9 tCO_2
Real World Range				
Average	296 km	288 km	253 km	275 km
Urban	253 km	239 km	214 km	232 km
Rural	342 km	315 km	284 km	302 km
Motorway	299 km	300 km	272 km	287 km

* WTW CO_2e compared to a diesel equivalent truck

NOTE: The results for Q1 and Q2 have been recalculated for this report using an improved methodology.

Vehicle Activity Summary

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

Due to logger issues, two vehicles (B-2 and H-1) are missing cab heater data for the majority of this quarter and are not included in any subsequent analysis involving ancillary energy consumption in this report.

Fleet	Active/Expected	Vehicle	Distance Travelled (km)	Days Driven
A	2/2	A-1	545	6
		A-2	1,375	16
B	2/2	B-1	6,189	44
		B-2	6,091	42
C	2/2	C-1	4,020	25
		C-2	8,708	38
D	2/2	D-1	2,084	28
		D-2	3,139	28
E	2/2	E-1	799	16
		E-2	2,008	26
F	1/1	F-1	130	5
G	1/1	G-1	3,870	54
H	1/2	H-1	7,059	61
I	1/1	I-1	603	21
J	2/2	J-1	862	25
		J-2	712	33
K	1/1	K-1	215	5
L	2/2	L-1	1,842	33
		L-2	5,256	87
Total	**19/20**		**55,507**	**593**

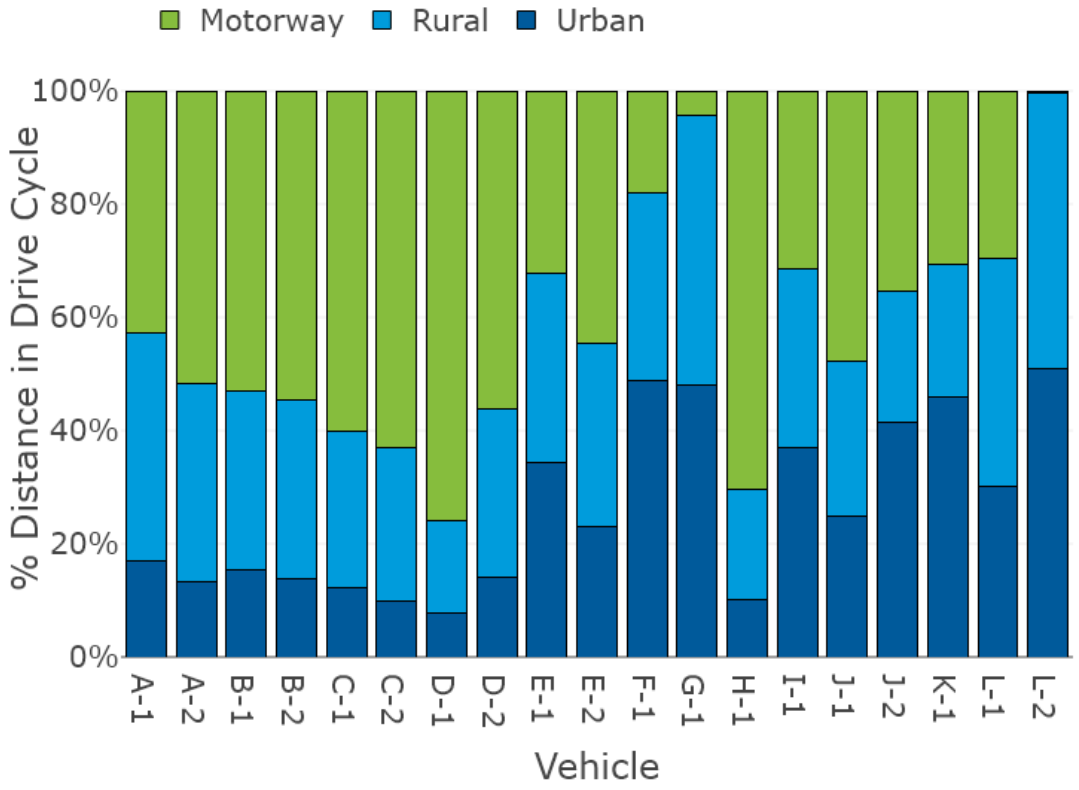
Drive Cycle

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 previous quarters, there has been a small reduction in motorway driving with it now making up less than half of total distance driven, and there is an increase in urban and rural driving.

G-1 and L-2 are notable for having almost no motorway driving. Both 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.

F-1 and K-1 have driven less than 150 km this quarter, so this data is not necessarily representative.



The average for all vehicles is:
Urban 21% | Rural 31% | Motorway 48%

Energy Efficiency

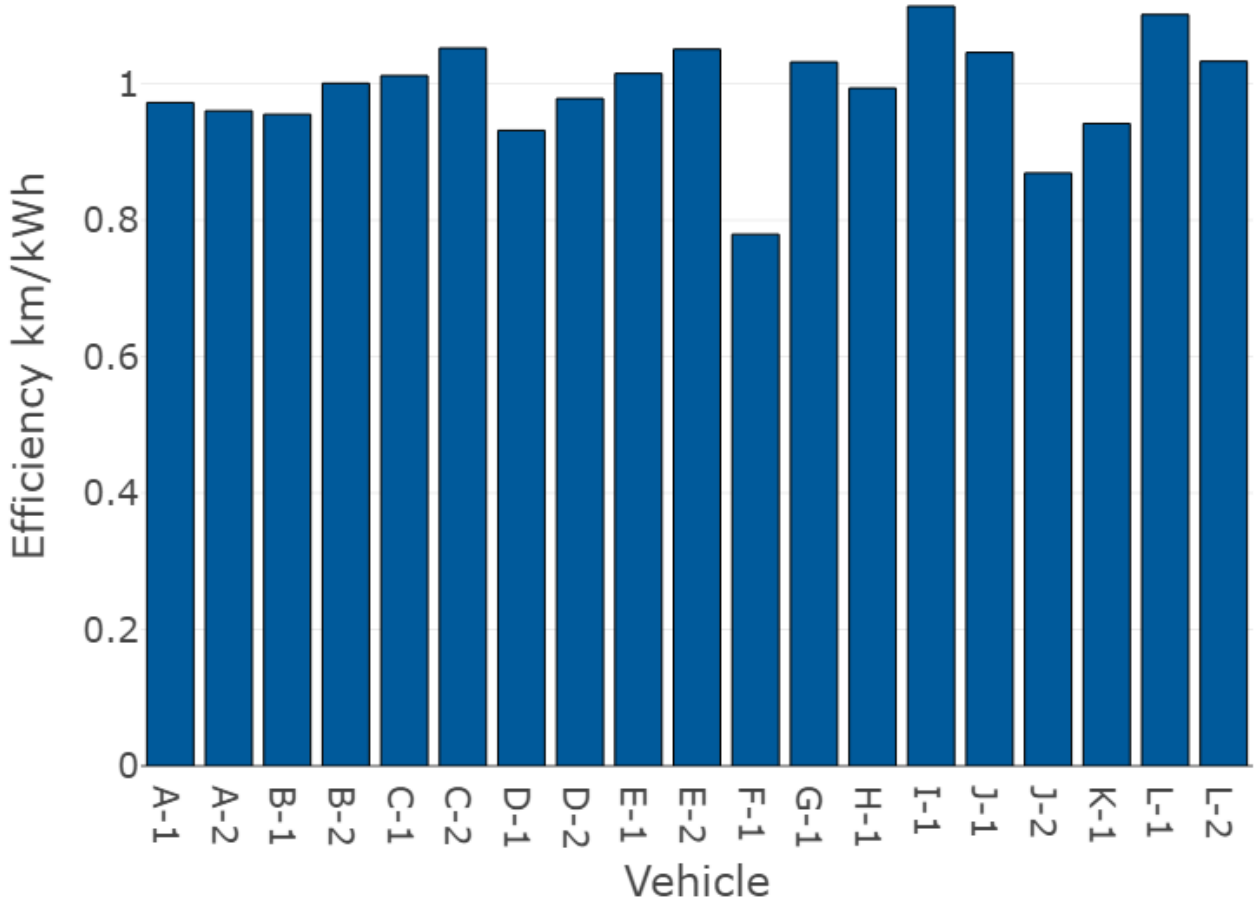
The energy efficiency of the trucks across all drive cycles ranges between **0.77** and **1.11 km/kWh**.

With a 250 kWh battery, that translates to a real-world range of between **195 km** and **278 km**.

The average real-world range observed during the trial this quarter is **253 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.

Vehicle F-1 has particularly low efficiency, but this is not representative due to very low distance travelled meaning the energy used for ancillaries is relatively high compared to other vehicles.

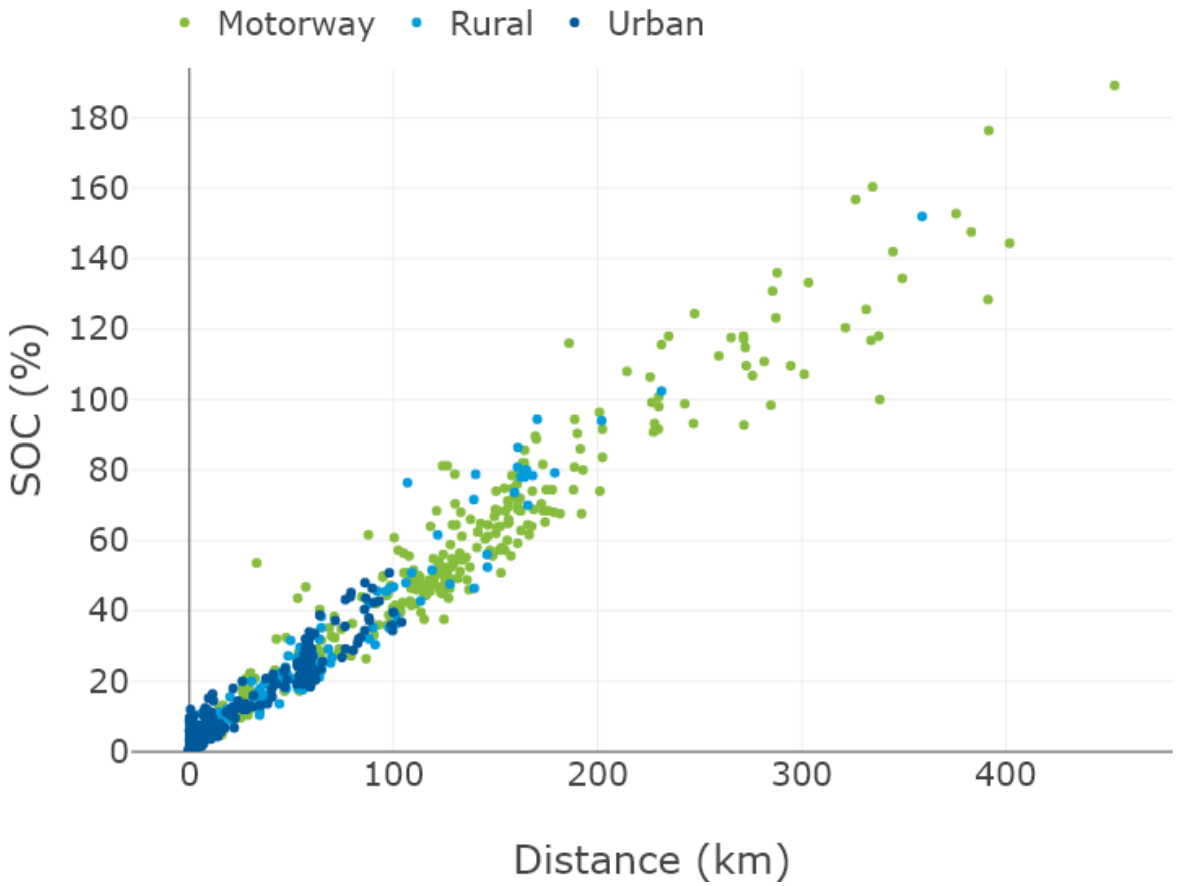


Daily Distance vs Battery State of Charge (SOC)

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 **453 km**.



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

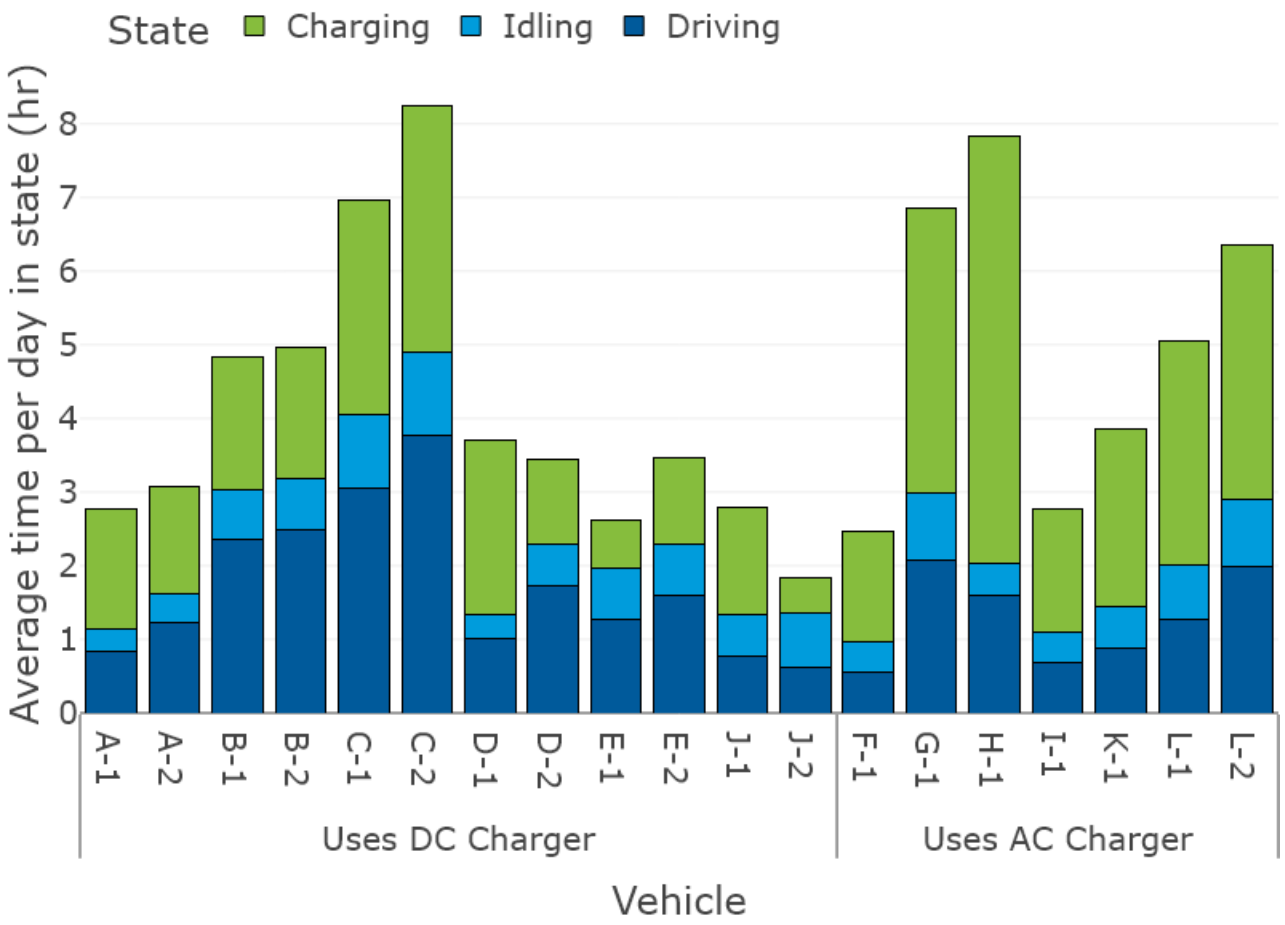
State Duration

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 Q3 the time to charge a vehicle compared to time spent driving has increased since Q2 due to the lower efficiencies. Vehicles using rapid DC chargers spend slightly less time charging than driving (92%) while those using slower AC chargers spend more than double the driving time charging, but both are roughly a fifth higher than Q2.

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



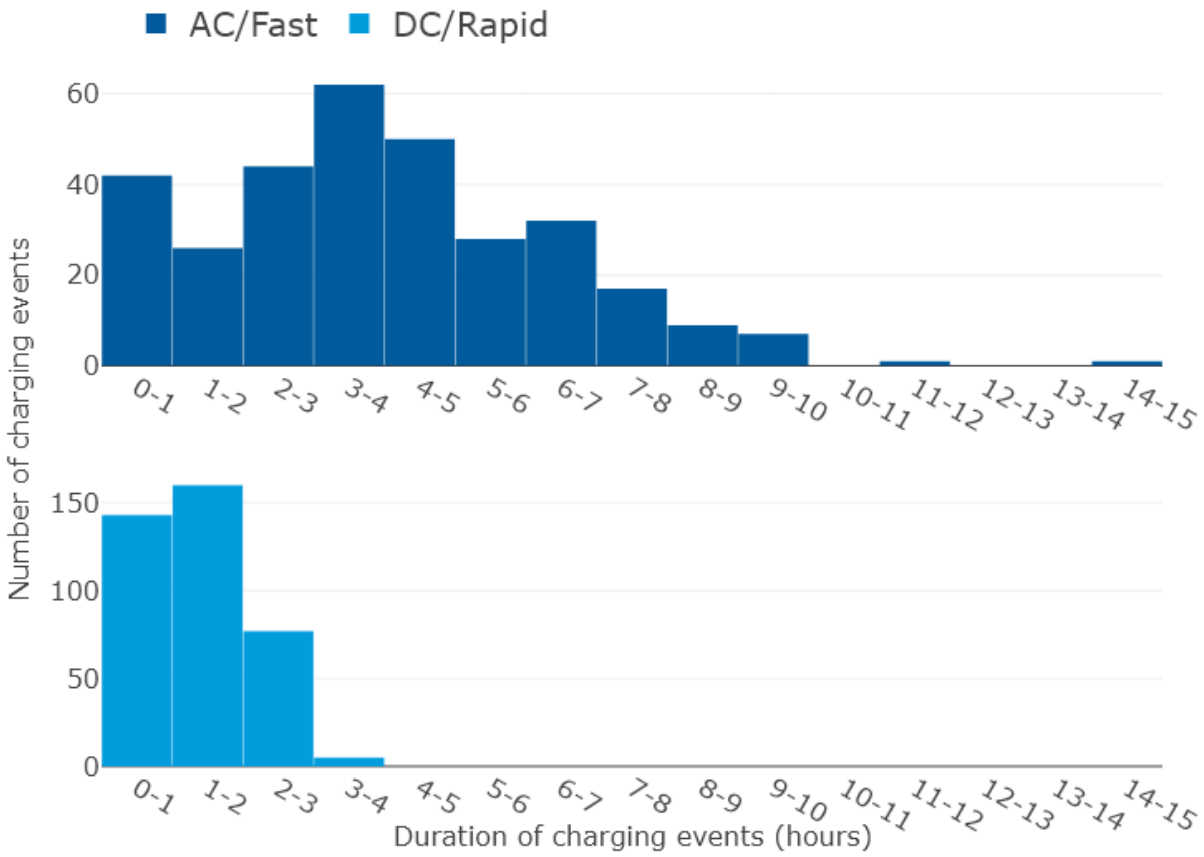
* Only includes days when vehicle is in use (driving or charging) for more than 20 minutes

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, so there are peaks at around **0-1 hours** for short top-ups and **3-5 hours** for longer overnight charges.

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



* Only charging sessions which last longer than 5 minutes are include

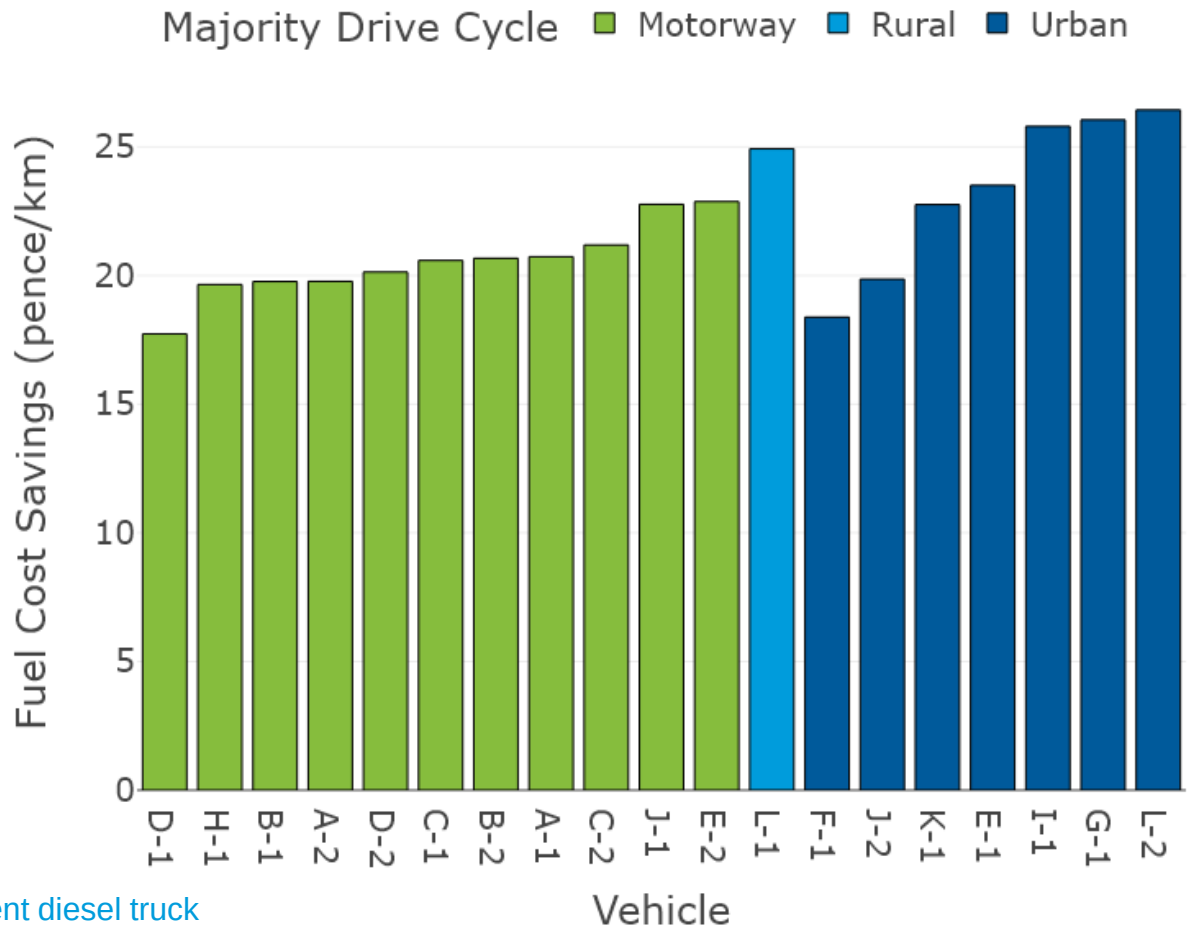
Fuel Savings

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

The average fuel savings range from 18p to 26p per km.

The fuel savings for a vehicle driving an annual distance of 50,000 km** would be between **£9,000** and **£13,000 per year**.

The vehicles with the highest average fuel saving are driving mostly in urban or rural environments which shows the relative inefficiency of diesel vehicles in start-stop situations.



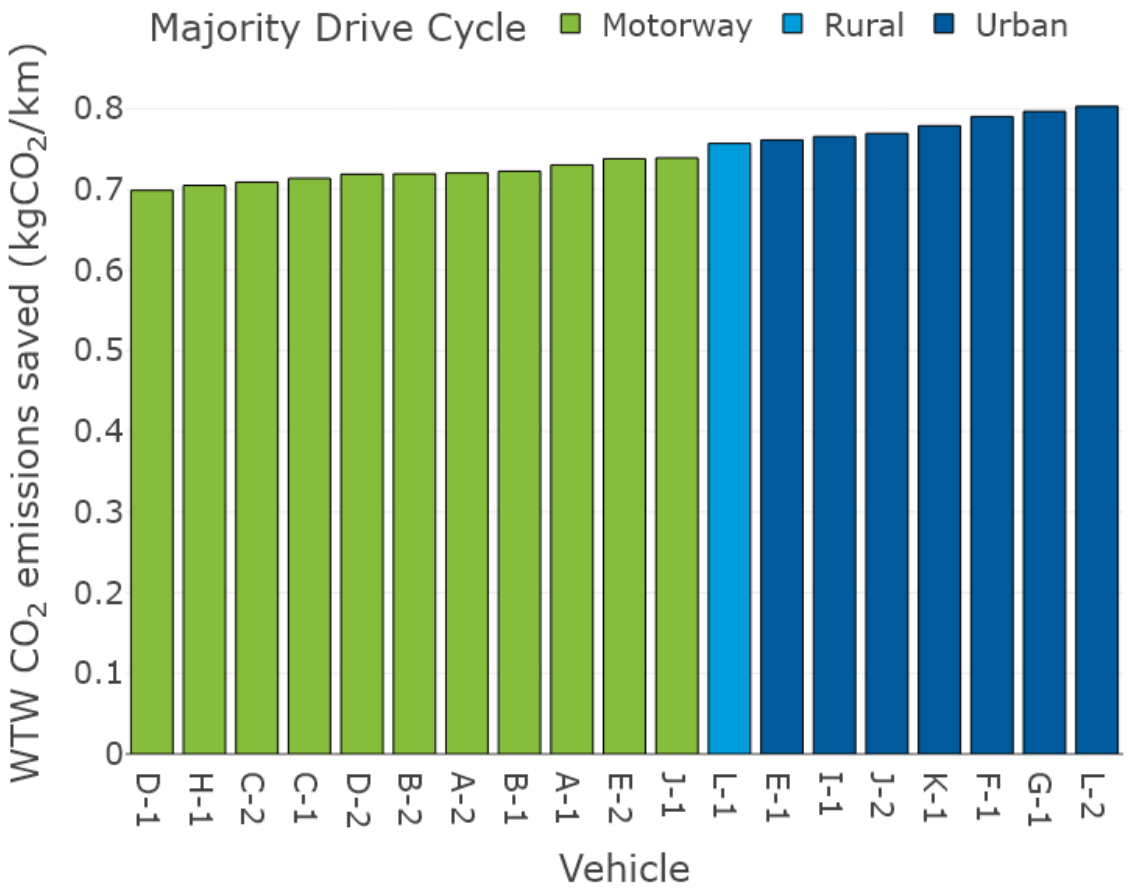
*These figures are generated using £1.90 p/l for diesel on an equivalent diesel truck and £0.23 per kWh for electricity. Figures only include energy from driving / idling

**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 **699 to 803 gCO_2/km**. The total WTW CO_2 saved in the third quarter of the trial was **40.7 t.**

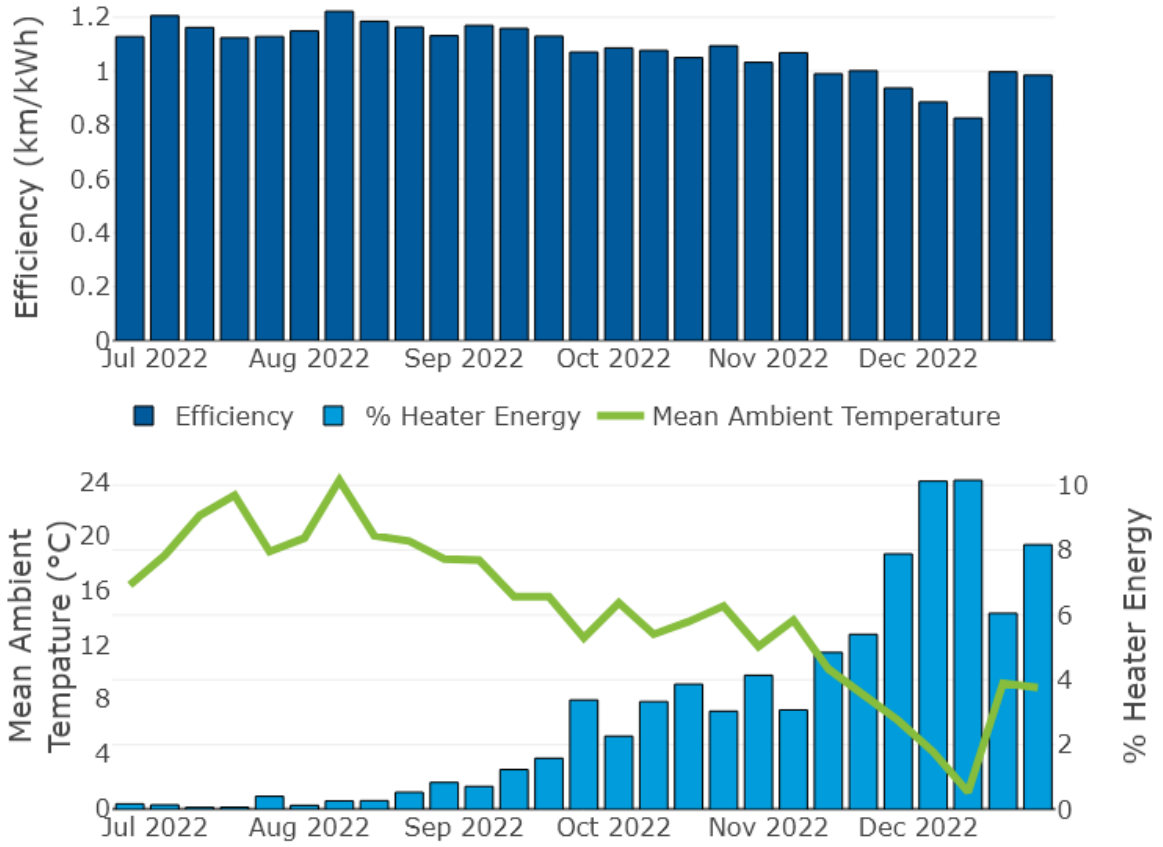


Case Study – Effects of Cold Weather

The efficiency of the electric trucks this quarter has been lower than previous quarters. This is due to the effects of cold weather.

The top graph shows the average efficiency across all vehicles for each week between July and December.* The bottom graph shows the mean ambient temperature each week, with the percentage of total energy used by the cab heater.

The lowest average weekly efficiency (0.83 km/kWh) occurred during the ‘cold snap’** in December. There is lower efficiency in cold weather due to the decreased efficiency of the battery and an increase in cab heater usage. During the ‘cold snap’ the cab heater usage reached 10.2% of total energy consumption.



* Figure excludes B-2 and H-1 due to them missing cab heater data.

** Weather: UK sees coldest night of the year as temperatures plunge to record low of -15.7C | ITV News

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