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BETT Quarterly Report

Trial Q5: April – June 2023

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Transport Team

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Document Control

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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 fifth quarter of the trial (April to June 2023).

Contents

Best of BETT this Quarter

453 km travelled in one day*

(Vehicle C-1, 11-05-2023, 169% battery used)

403 kWh used in one day*

(Vehicle C-1, 11-05-2023, 169% battery used)

08:49 hours worked** in one day*

(Vehicle C-1, 04-04-2023, 130% battery used)

421 kWh charged in one day

(Vehicle C-1, 11-05-2023, 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)	Q5 (Apr-Jun 2023)	Total
Active Trucks	12	18	19	18	18	20
Total Distance	15,911 km	53,240 km	55,507 km	31,591 km	50,387 km	206,636 km
Total Energy	13,609 kWh	47,091 kWh	57,833 kWh	38,309 kWh	49,314 kWh	206,156 kWh
Total Number of Journeys	697	2,470	3,222	2,150	2,860	11,399
Total Emissions Savings*	11.5 tCO_2	38.7 tCO_2	40.7 tCO_2	23.4 tCO_2	37.3 tCO_2	151.6 tCO_2
Real World Range						
Average	296 km	288 km	253 km	241 km	277 km	273 km
Urban	253 km	239 km	214 km	206 km	235 km	223 km
Rural	342 km	315 km	284 km	274 km	303 km	298 km
Motorway	299 km	300 km	272 km	260 km	295 km	285 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 vehicles **H-1** and **K-1** not having representative distances travelled during this quarter, they have been excluded from most of the reporting.

Due to a logger issue, we only have complete data for half of the quarter for vehicle **B-2**. The total distance is included in the table on the right, but analysis on the previous and following pages only include periods where we have full data.

Overall, compared to the last quarter, the vehicles have travelled greater distances and driven on more days.

Fleet	Active/Expected	Vehicle	Distance Travelled (km)	Days Driven
A	2/2	A-1	2868	36
		A-2	3134	41
B	2/2	B-1	4215	44
		B-2	7832	56
C	2/2	C-1	8587	53
		C-2	4315	28
D	2/2	D-1	1895	21
		D-2	3202	36
E	2/2	E-1	4396	44
		E-2	1744	19
F	1/1	F-1	254	11
G	1/1	G-1	5076	66
H	2/2	H-1	193	15
		H-2	2532	39
I	1/1	I-1	399	20
J	2/2	J-1	774	68
		J-2	806	40
K	1/1	K-1	46	6
L	2/2	L-1	1826	49
		L-2	1937	68
Total	**20/20**	**Total**	**56,031**	**760**

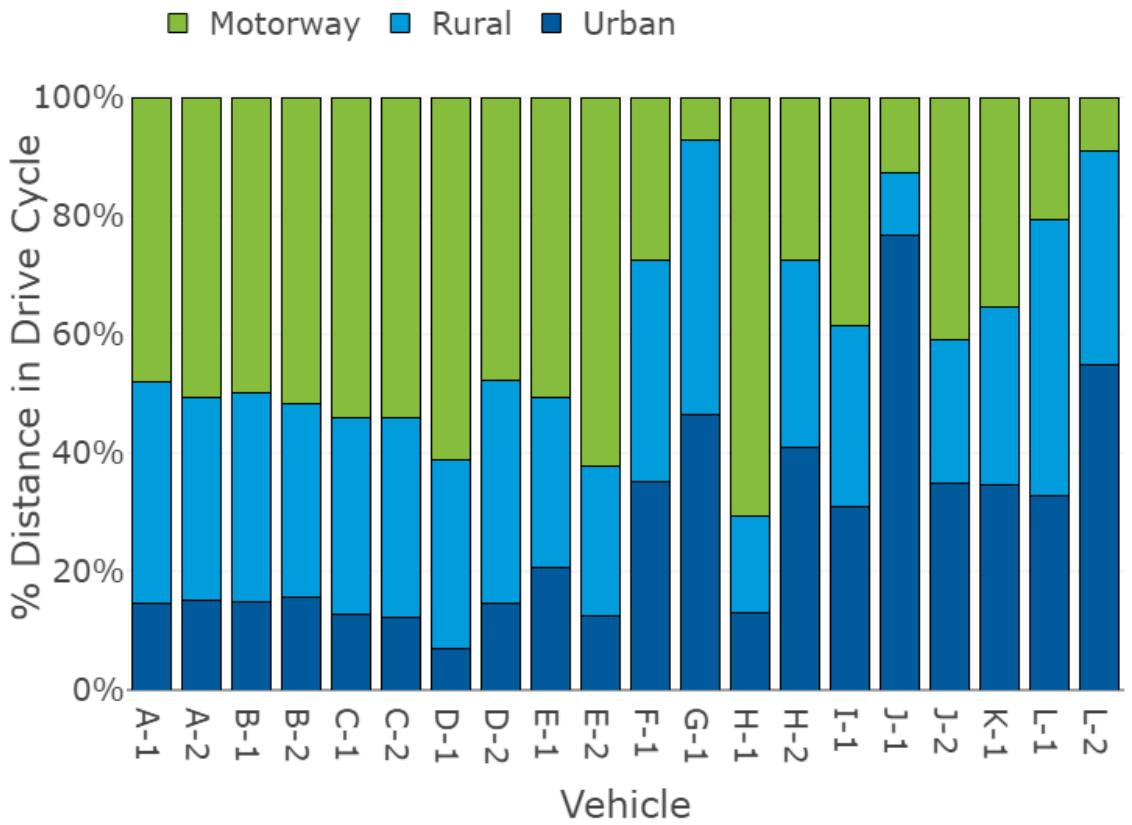
Drive Cycle

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 Q4 there has been slightly less urban driving, while there has been a 1% increase in rural and motorway driving.

Vehicles **H-1** and **K-1** have had low mileages this quarter, so their data are not necessarily representative.

Vehicle **J-1** has a high proportion of urban driving due to it carrying out lots of short journeys this quarter.



The average for all vehicles is:

Urban 22% | Rural 34% | Motorway 44%

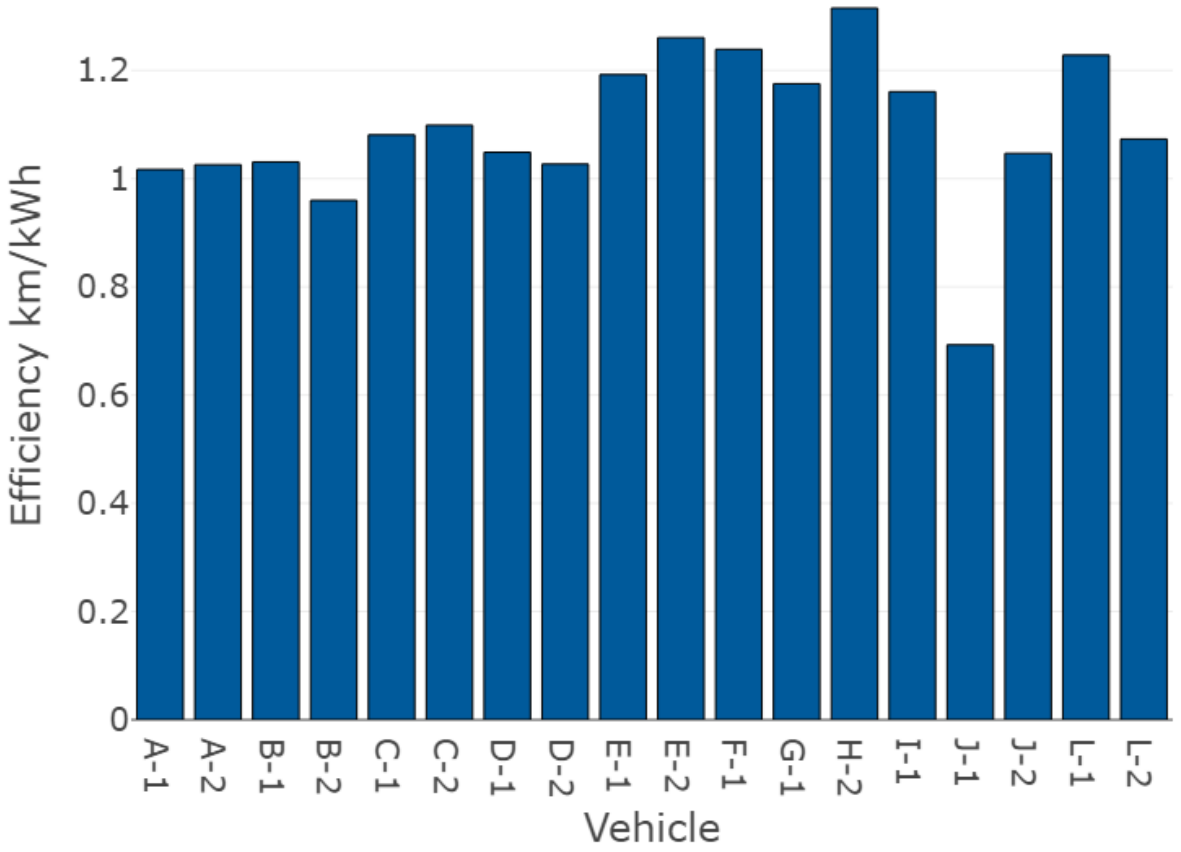
Energy Efficiency

The energy efficiency of the trucks across all drive cycles ranges between **0.69** and **1.32 km/kWh,** which is similar to the range from the same period last year.

With a 250 kWh battery, that translates to a real-world range of between **173 km** and **330 km**. The average real-world range observed during the trial this quarter is **273 km**.

The low efficiency of 0.69 km/kWh is due to **J-1** having a high proportion of ancillary consumption this quarter, due to lots of small journeys, with a high proportion of its time idling.

The energy efficiency is higher in this quarter due to the warmer weather. All vehicles, battery electric or combustion engine, tend to have higher efficiencies in warmer weather. Less cab heater usage with warmer temperatures will also help to increase efficiency.

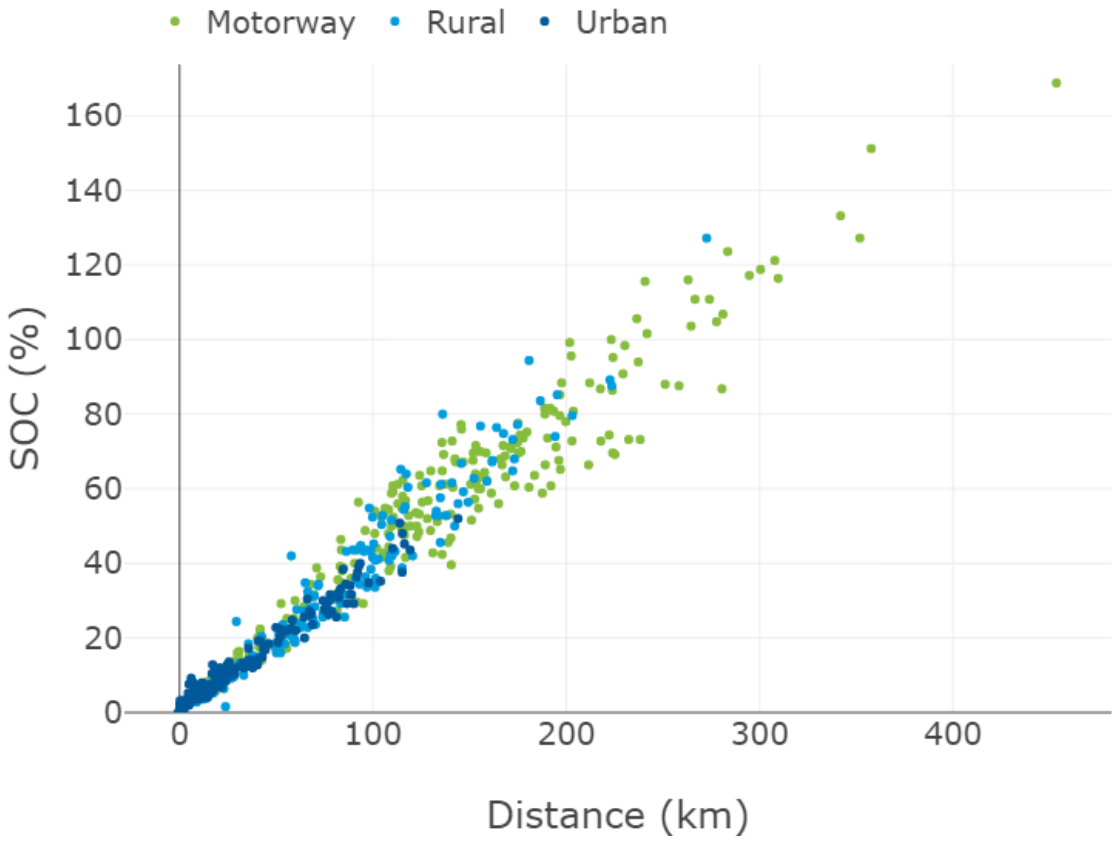


Daily Distance vs Battery State of Charge (SOC)

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 top up charges with rapid charging during the day, with a peak distance of **453 km**.



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

State Duration

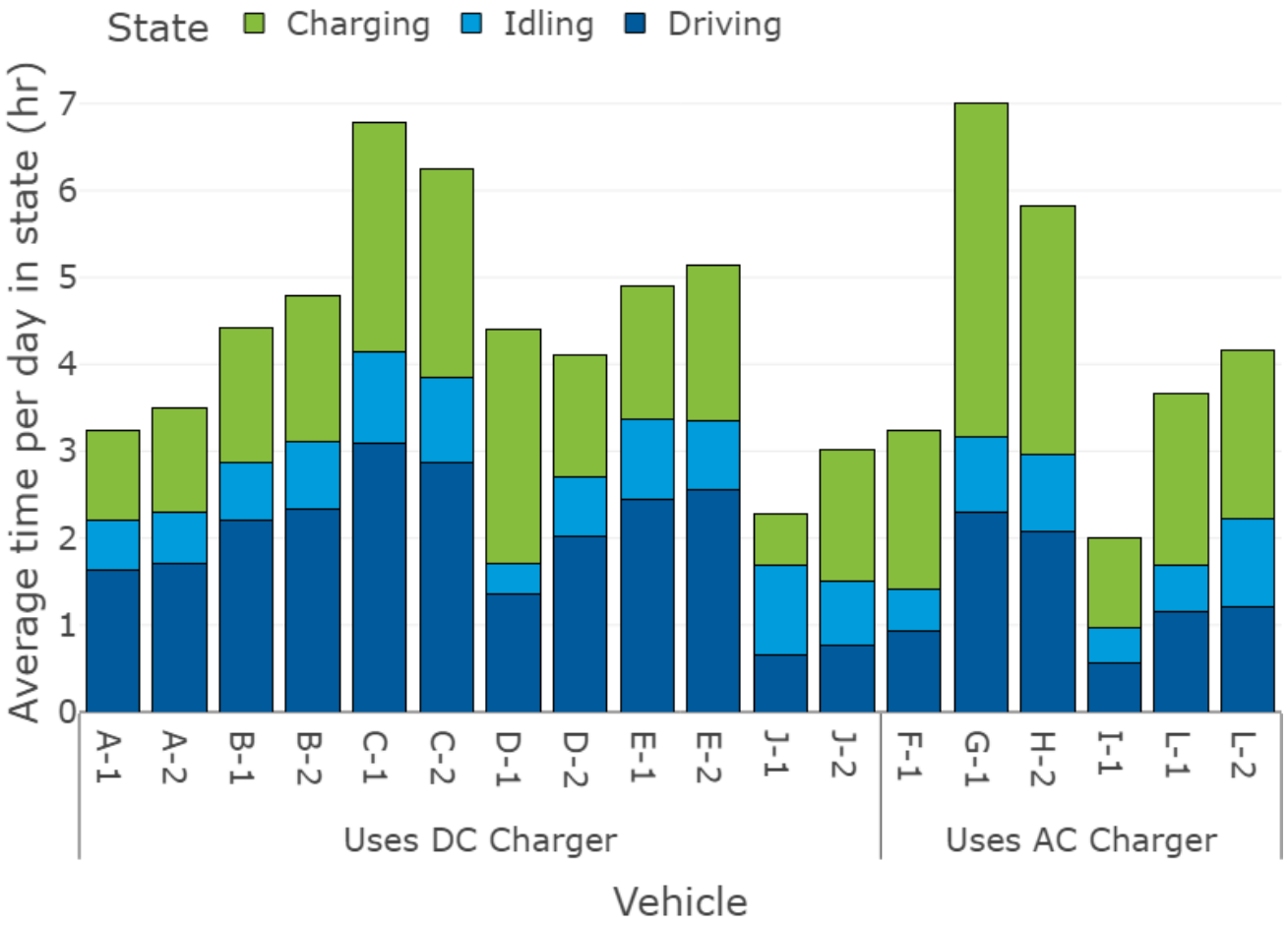
A vehicle is in one of four states: driving, charging, idling (e.g. at traffic lights) and parked.

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 Q5, the time spent charging compared to time spent driving has decreased compared to Q4. This is due to the higher vehicle efficiencies in this quarter.

For the first time since Q2, vehicles using fast charging spend less than double the driving time charging. Vehicles using rapid charging spent less time charging than driving.

Quarter	Charging time as percentage of driving time	
	AC (fast)	DC (rapid)
Q2	178%	76%
Q3	233%	92%
Q4	266%	117%
Q5	**161%**	**83%**



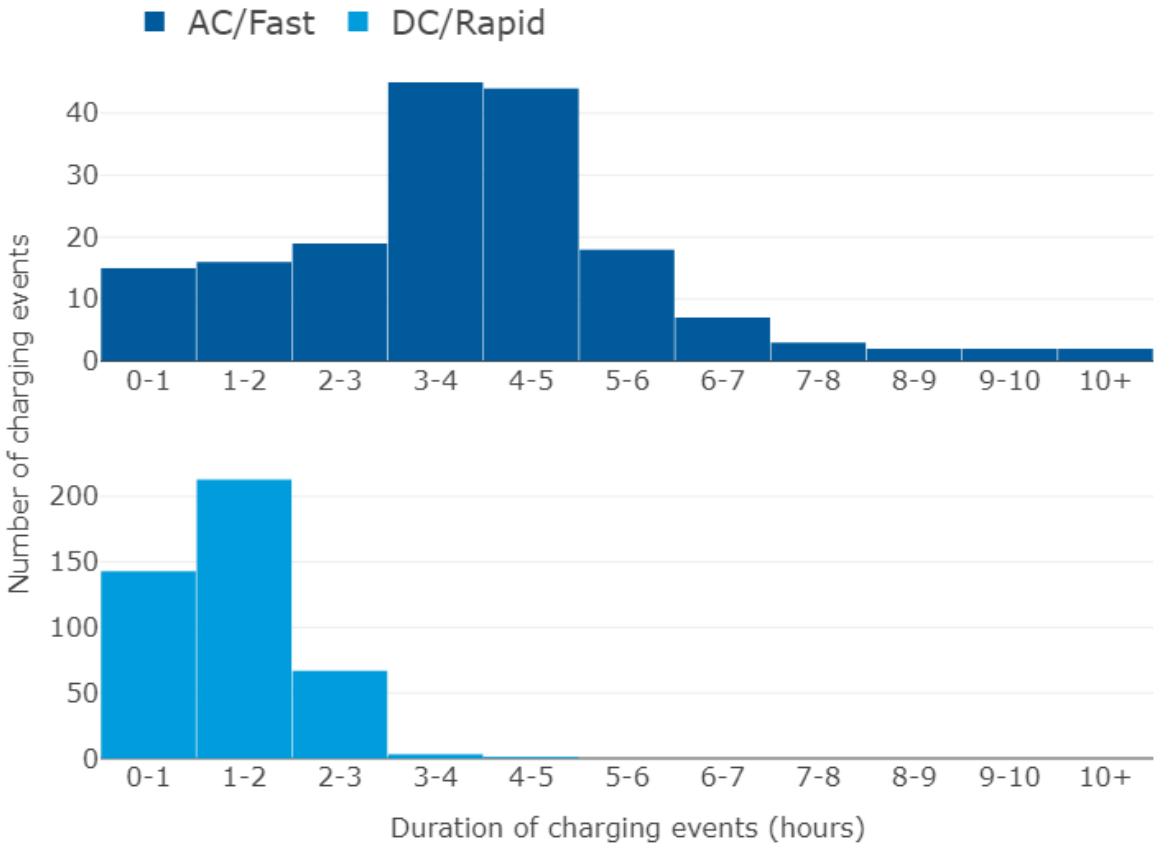
* Only includes days when vehicle is in use (driving or charging) for more than 20 minutes.

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. The majority of charges were longer sessions used for full charges, lasting between **3-5 hours**.

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



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

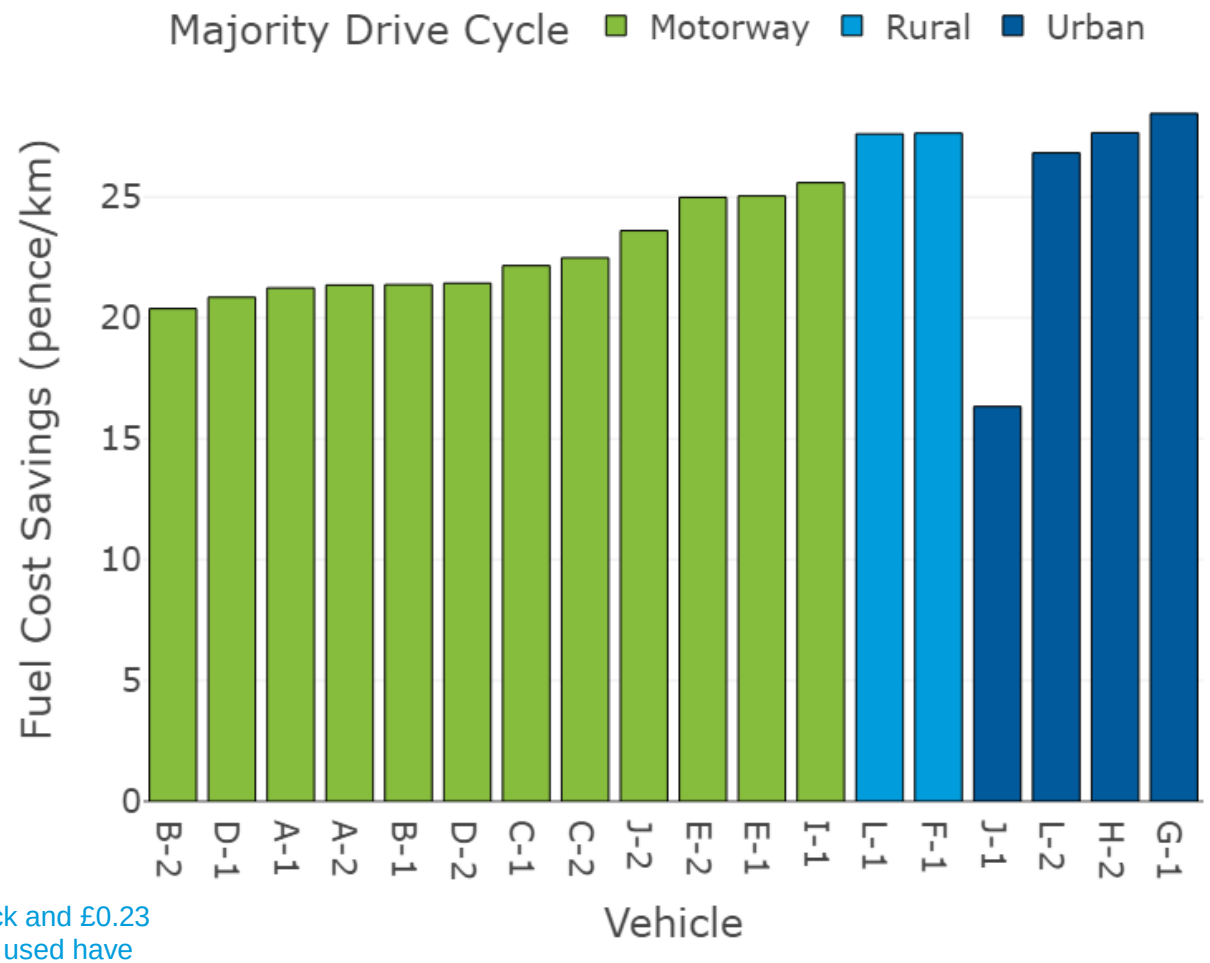
Fuel Savings

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

The average fuel savings range from **20p to 29p per km**, except for **J-1**, which was **16p per km**, due to it being used for short journeys and having a higher proportion of ancillary consumption.

The fuel savings for a vehicle driving an annual distance of 50,000 km** would be between **£8,000** and **£14,500 per year**.

Fuel savings have increased this quarter due to warmer weather causing an increase in vehicle efficiency.

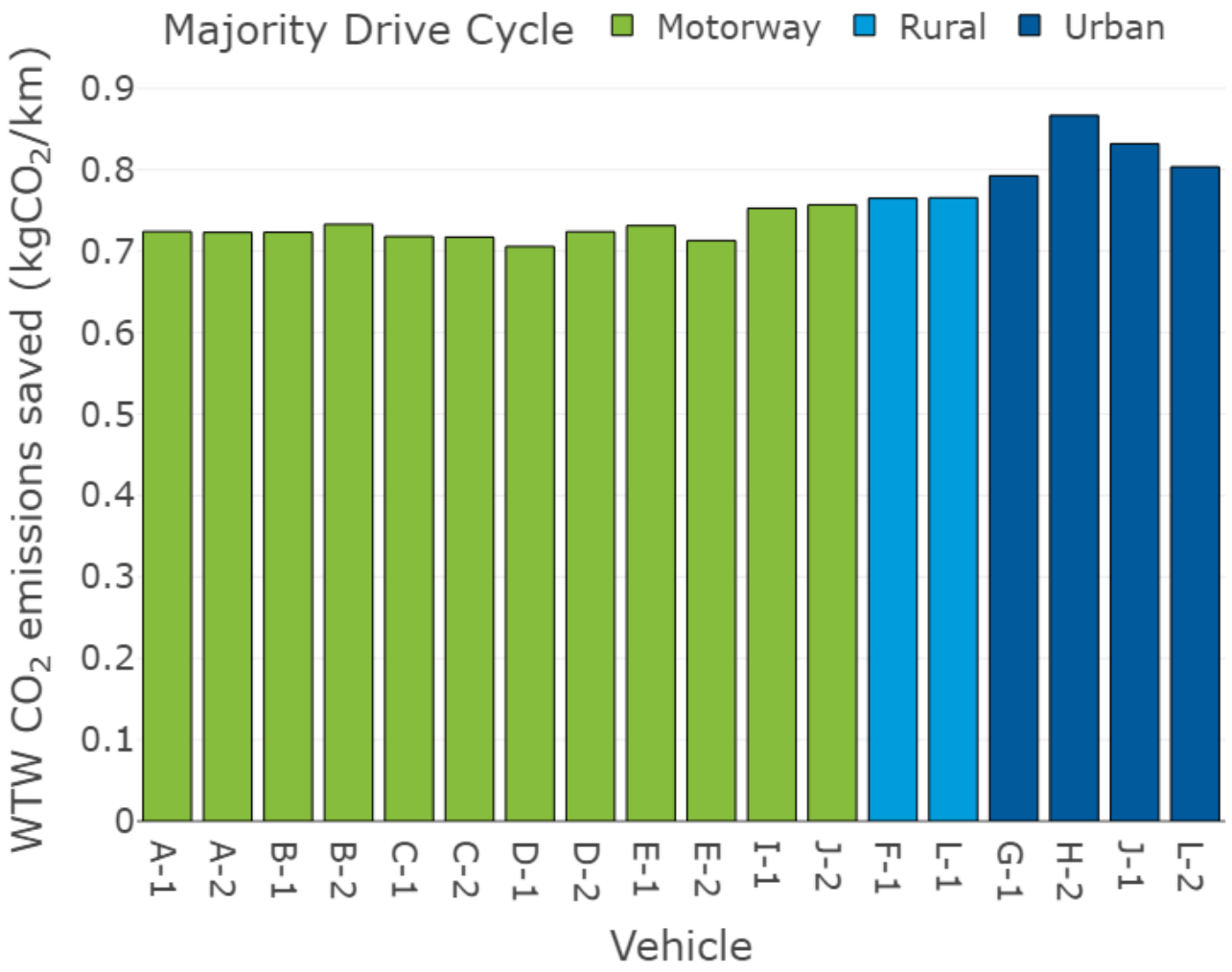


*These figures are generated using £1.90 p/l for diesel on an equivalent diesel truck and £0.23 per kWh for electricity. Figures only include energy from driving / idling. The prices used have been maintained to provide consistency with previous reports.
**Average annual distance in UK for 17-25t rigid 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 **706 to 866 gCO_2/km**. The total WTW CO_2 saved in the fourth quarter of the trial was **37.3 tCO_2.**



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

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