Transport | Energy Infrastructure | Knowledge & Enterprise

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BETT Quarterly Report

Trial Q2: July – September 2022

Cenex

Transport Team

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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 second quarter of the trial (July to September 2022).

Contents

Best of BETT

484 km travelled in one day*

(Vehicle B-1 – 12/09/2022, 186% battery used)

439 kWh used in one day*

(Vehicle B-1 – 12/09/2022, 186% battery used)

09:33 hours worked** in one day*

(Vehicle B-1 - 26/07/2022, 170% battery used)

527 kWh charged in one day

(Vehicle B-1 – 26/07/2022, 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 22)	Q2 (Jul-Sep 22)	Total
Active Trucks	12	18	18
Total Distance	15,932 km	52,060 km	67,992 km
Total Energy	13,764 kWh	46,538 kWh	60,302 kWh
Total Number of Journeys	795	2,414	3,209
Total Emissions Savings**	11.5 tCO_2	37.8 tCO_2	49.3 tCO_2
Real World Range			
Average	305 km	280 km	282 km
Urban	252 km	235 km	238 km
Rural	346 km	314 km	320 km
Motorway	300 km	299 km	299 km

* Three vehicles had missing battery data for some of the quarter, this table shows only the distance covered with full data. See next slide for total distance. ** WTW CO_2e 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 logger issues, three vehicles (A-2, B-2 and L-1) are missing battery data for the majority of this quarter and are not included in any subsequent analysis involving energy consumption in this report.

However, we do know the distance they travelled, which is shown in this table.

C-1 is also excluded from the analysis as there is only data available for the last day of the quarter.

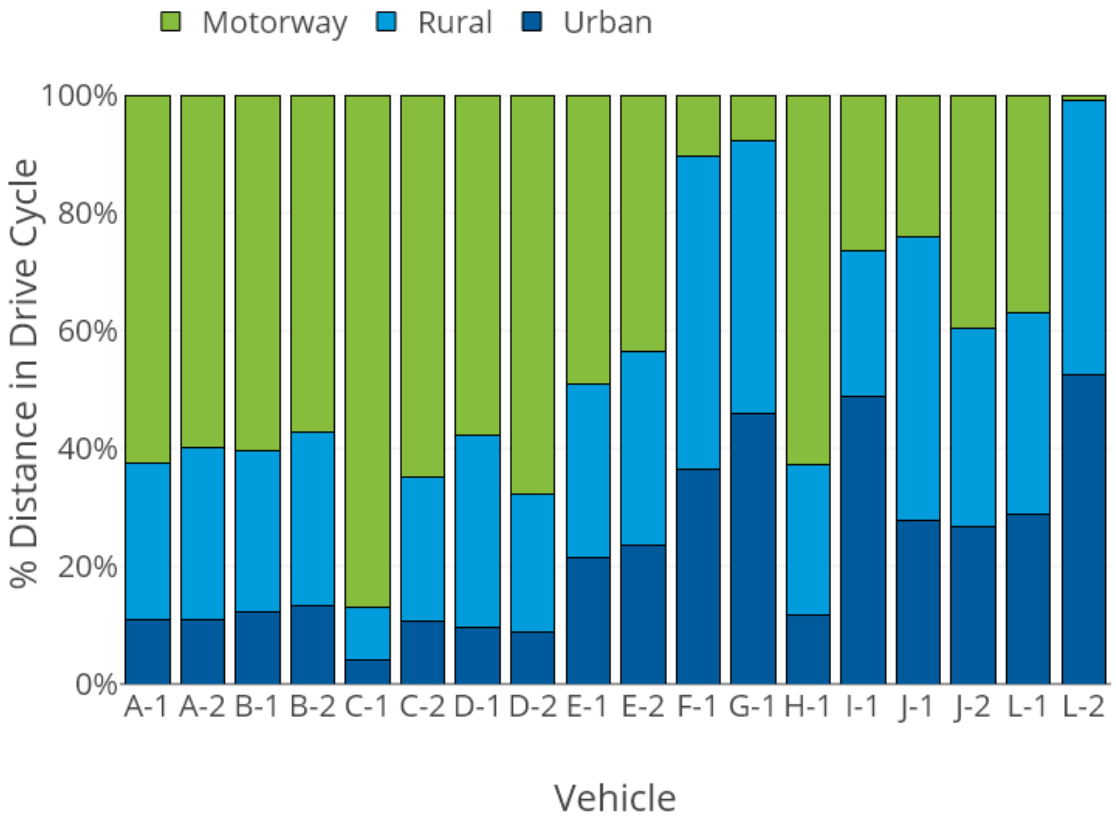
Fleet	Active/Expected	Vehicle	Distance Travelled (km)	Days Driven
A	2/2	A-1	10,143	65
		A-2	9,908	64
B	2/2	B-1	13,811	70
		B-2	9,525	62
C	2/2	C-1	140	1
		C-2	6,171	49
D	2/2	D-1	1,394	17
		D-2	1,090	18
E	2/2	E-1	3,980	54
		E-2	2,259	43
F	1/1	F-1	130	12
G	1/1	G-1	5,038	63
H	1/2	H-1	3,183	41
I	1/1	I-1	480	22
J	2/2	J-1	296	4
		J-2	859	20
K	0/1	-	-	-
L	2/2	L-1	1,358	23
		L-2	1,083	23
Total	**18/20**		**70,848**	**581**

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.

Most vehicles exhibit a motorway drive cycle for more than half of the distance travelled because, although they mostly operate within the cities they are based in, they often use major trunk roads and ring roads to move between destinations.

F-1, G-1 and L-2 exhibit mostly rural or urban drive cycles, and the remainder are mixed. G-1 and L-2 are classified as mostly urban/rural because they mostly drive in city centres, which have lower speeds and more stops and starts. C-1 and F-1 have driven less then 150 km this quarter, so their data should not be considered representative.



The average for all vehicles is:
Urban 16% | Rural 30% | Motorway 54%

Daily Distance vs Battery State of Charge (SOC)

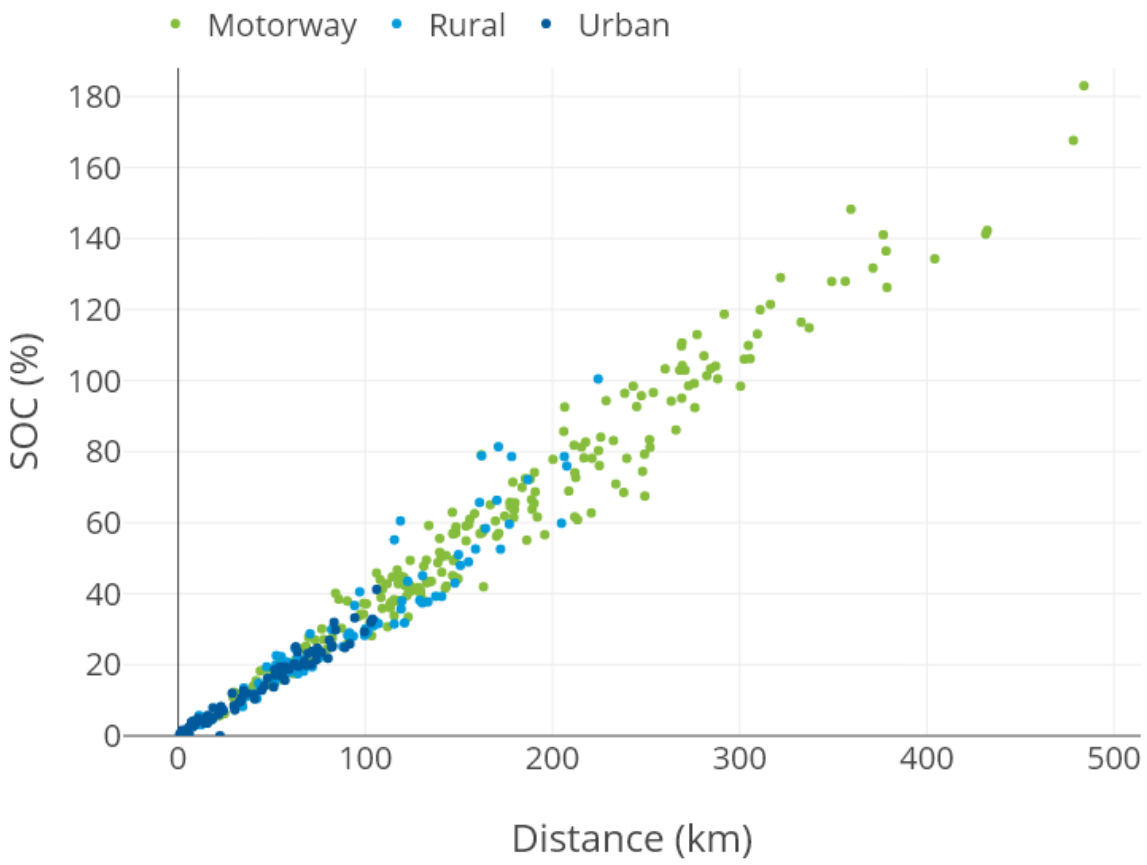
This graph shows how far vehicles travelled in a day, and how much battery state of charge (SOC) was used*.

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

There have been many more days this quarter when vehicles have used more than 100% charge, which is possible due to top-up charging with a rapid charger.

The increase from last quarter is due to 3 heavily used vehicles (i.e. long distance, several shifts, and rapid charging) that drove many more days this quarter.

The most SOC used in a day reached **183%**, which included 4 rapid charges, with time to spare to travel further and still charge to full at the end of the day.



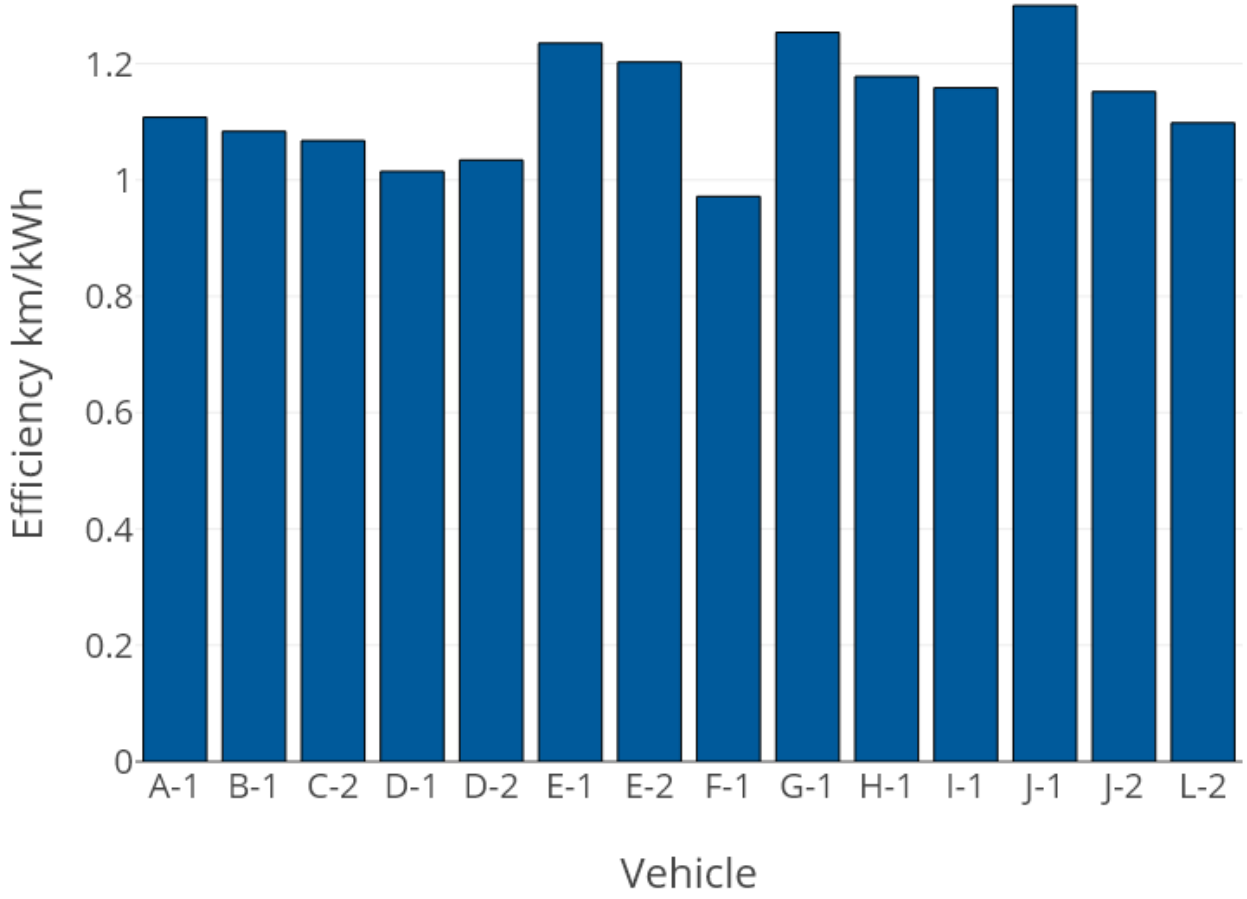
* Only takes into account SOC used for propulsion

Energy Efficiency

The energy efficiency of the trucks across all drive cycles ranges between 0.97 and 1.25 km/kWh.

With a 250-kWh battery, the range of the vehicles would therefore be between **243 km** and **313 km**.

The average real-world range observed during the trial this quarter is **280 km**.



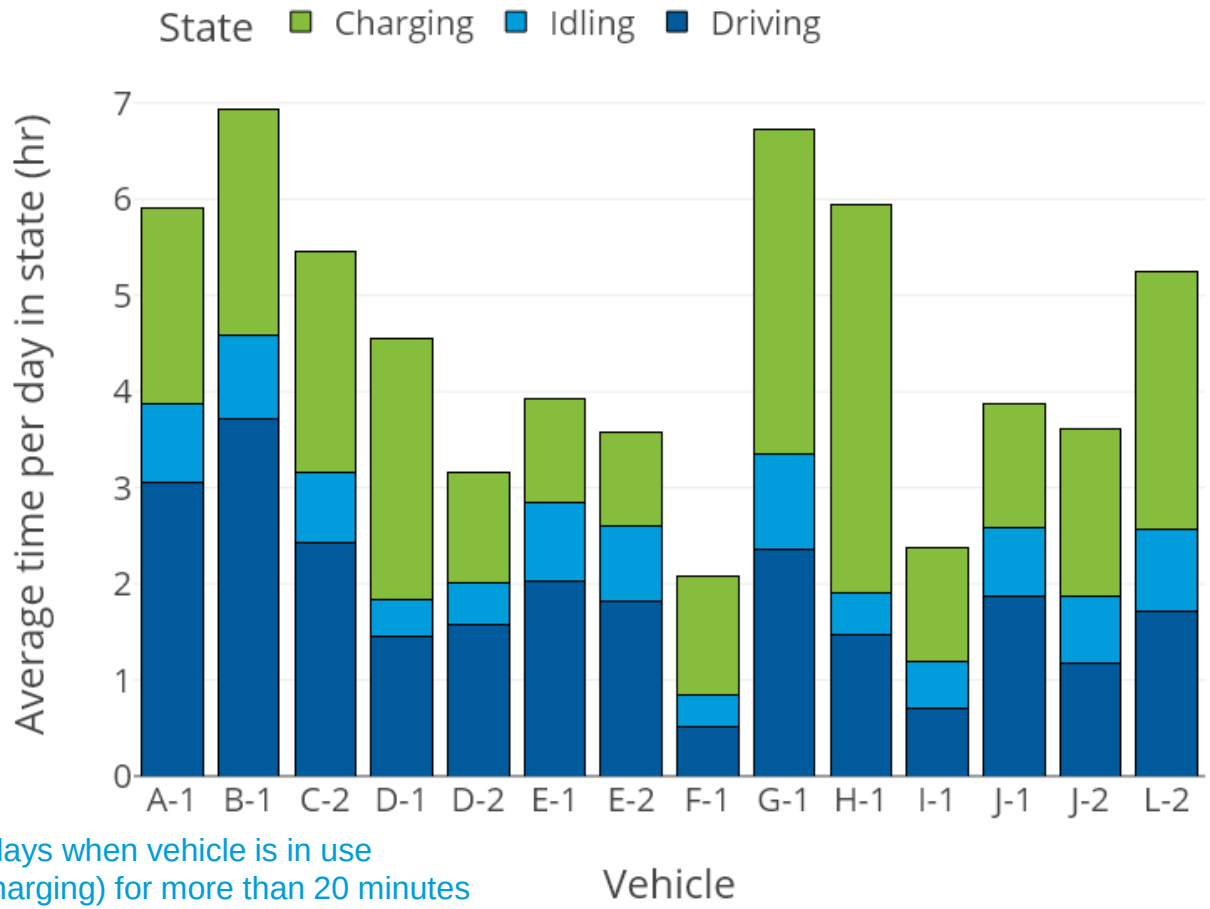
State Duration

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.

On average vehicles are spending less time charging this quarter. However, there are more charging events in total. This is because there are vehicles that began their operation this quarter which mostly use rapid chargers.

State	Average time per day (hours) *	
	Q1	Q2
Driving	1.6	2.3
Idling	0.6	0.8
Charging	2.8	2.3



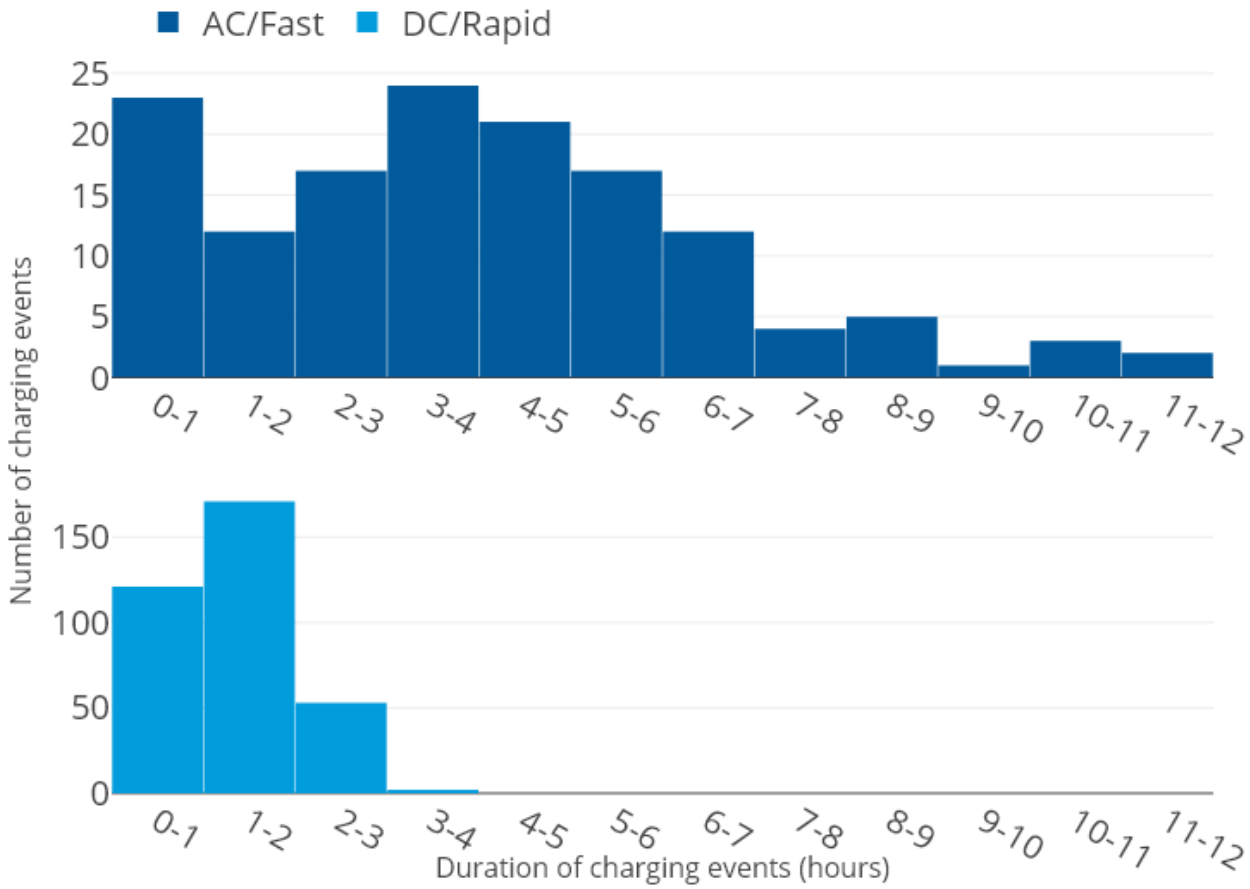
*Only uses days when vehicle is in use (driving or charging) for more than 20 minutes

Charging Duration

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

71% of charging sessions use a DC rapid charger. This has increased from last quarter because the vehicles that started the trial this quarter exclusively use rapid chargers. DC rapid charging sessions tend to take less than **2 hours**.

AC charging is used both for top-up charging and overnight charging, so we see peaks around **0-1 hours and 3-5 hours**.



*This only uses charging sessions which last longer than 5 minutes

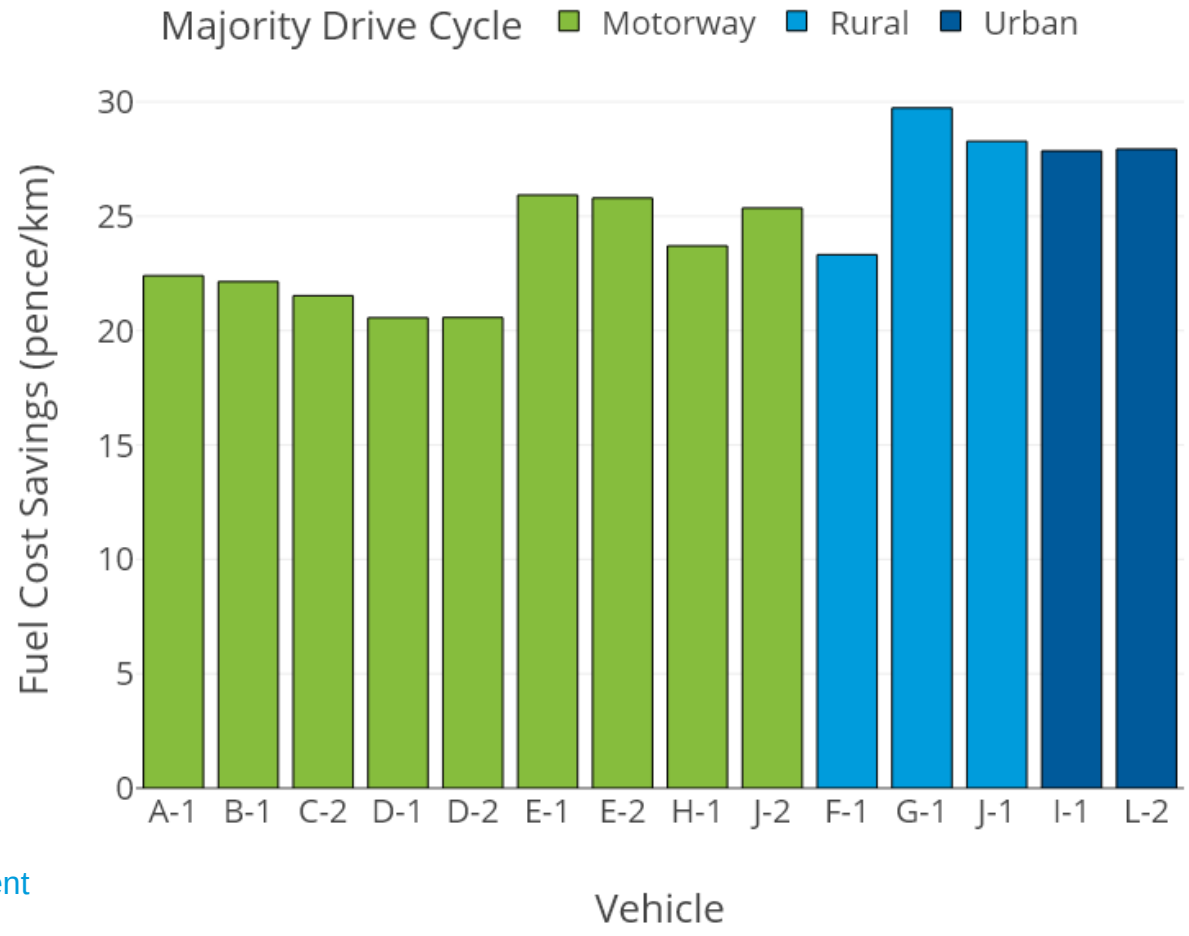
Fuel Savings

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

The average fuel savings range from 21p to 30p per km.

The fuel savings for a vehicle driving an annual distance of 50,000 km** would be between **£10,500** and **£15,000 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.

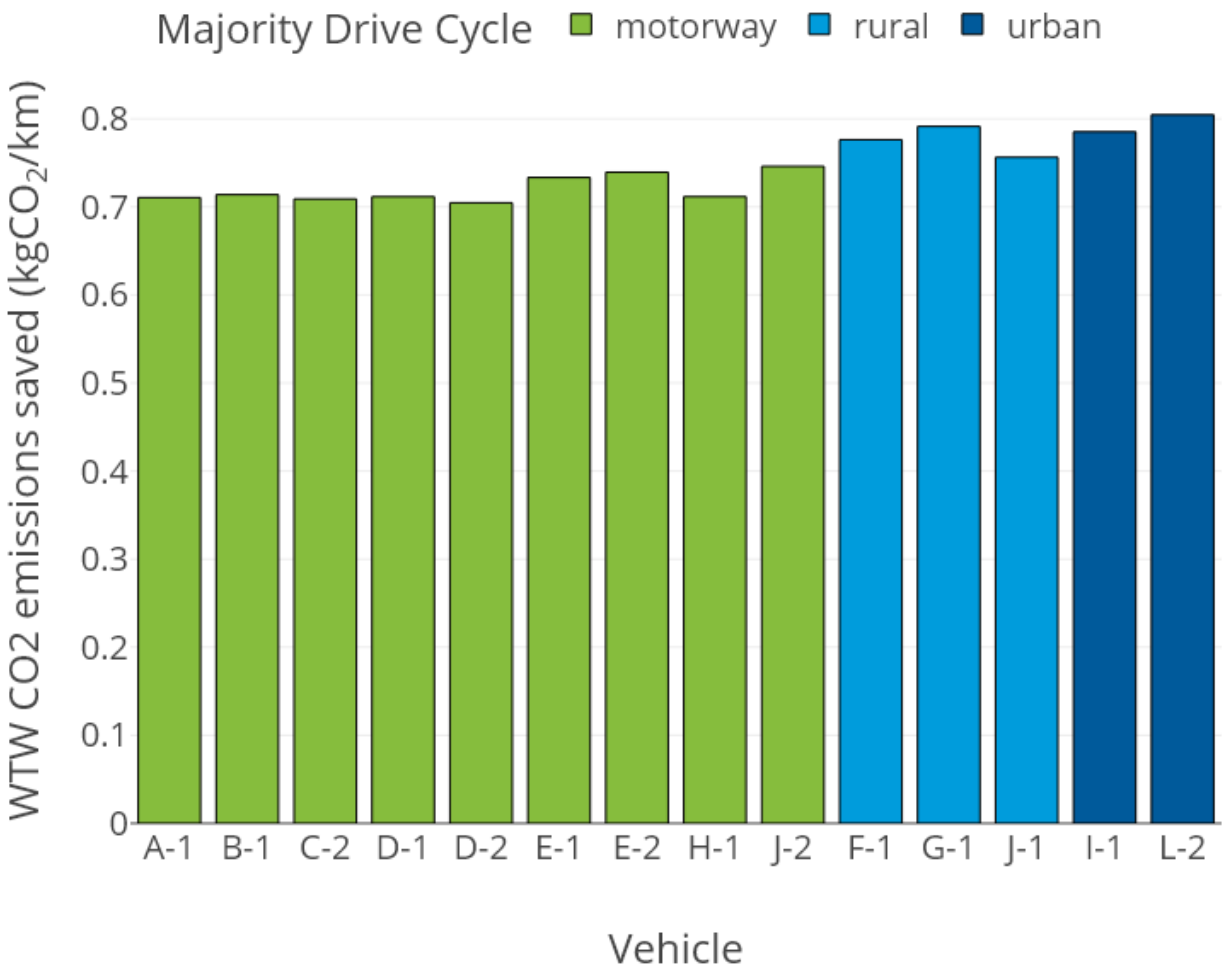


*These figures are generated using £1.90 p/l for diesel on an equivalent diesel truck and £0.23 per kWh for electricity.
**Average annual distance in UK for 17-25t rigid trucks (source: DfT)

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 per km range from **704 to 805 gCO_2/km**. The total WTW CO_2 saved in the second quarter of the trial was **37.8 t.**



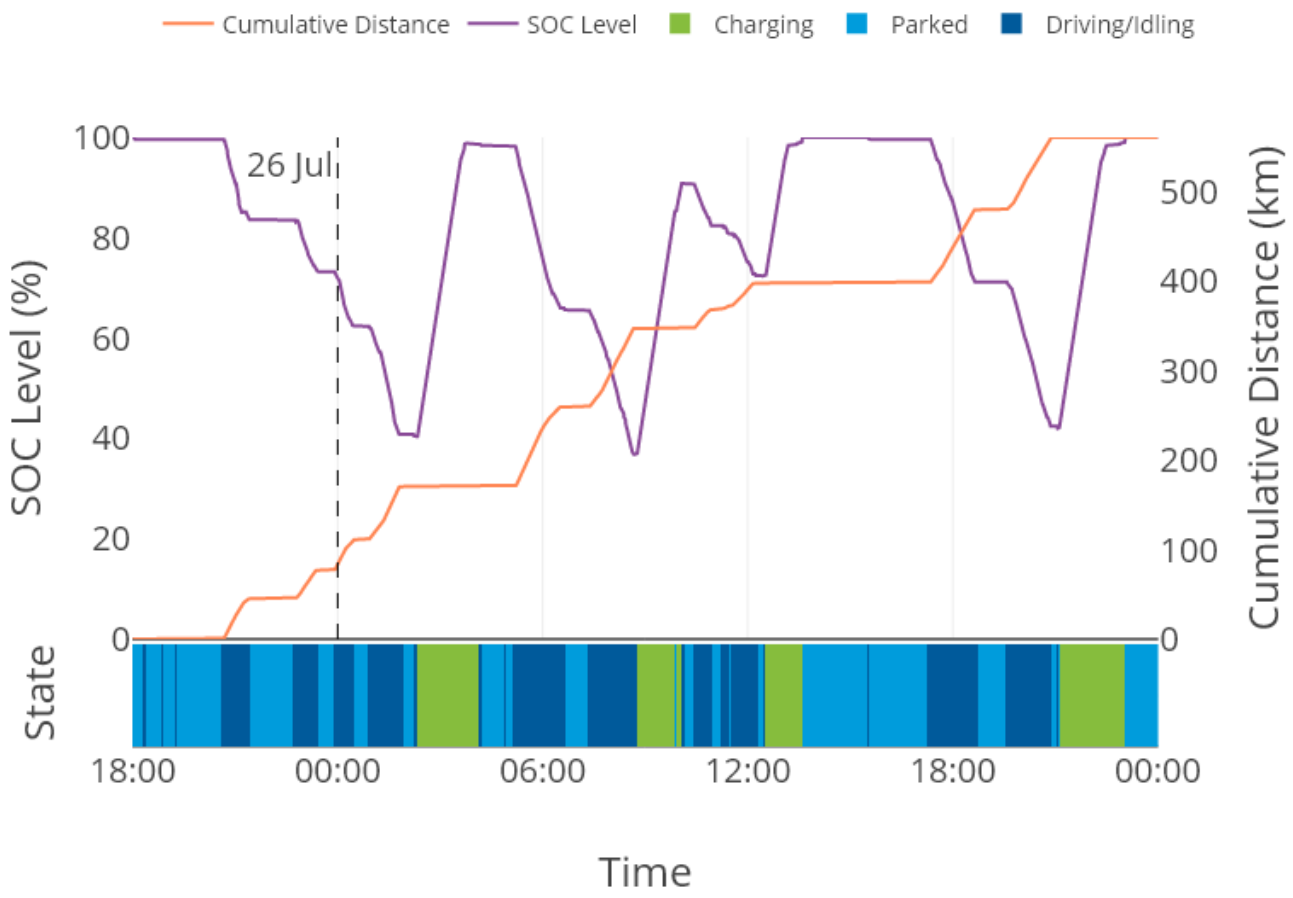
Case Study of High Usage Day

This case study shows how to make the most use out of an electric truck.

The vehicle travelled 560 km in 28 hours using 498 kWh, with 4 charging events adding 523 kWh in total (the difference is due to efficiency losses in the battery). The vehicle finished its overnight shift at 41% SOC, then charged back up to full in 1 hour and 48 mins, essential for the day's driving.

It then drove for 176 km and started charging before a second shorter shift of 51 km. After this, the vehicle charged to full and remained parked for nearly 5 hours before it's final shift.

The long gap before the final shift means that the final charging session could have been achieved using an AC/fast charger instead as it only required ~14kW of power to fully charge before the next shift, demonstrating that long distances can be achieved even if slower chargers are used.



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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