

UK eBUS Summit Low Carbon Vehicle Partnership

10 November 2016

Electric Buses In London

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Electric Bus Trials

- Electric bus fleet: 17 single deck buses (BYD, Optare Metrocity, Irizar). Five BYD pure electric double decks and 51 ADL/BYD pure electric single deck buses from Autumn 2016.
- Primary focus on EV performance (battery management, drive train, duty cycles, charging strategies) other areas of interest, build quality, production methods and weight saving strategies (lighter seating, alloy wheels) driver and engineering feedback
- Operational in service experience to date: Batteries, charging technology and drive train continue to be reliable with good performance
- Four routes, and four different vehicle types employing different charging strategies, further adding to our operational experience, and knowledge.
- Charging infrastructure
- To date we have received no negative feedback from passengers.
- EV Battery Performance Data Loggers on five buses to further assist with real world conditions



Electric Bus Trials

- Measure bus performance in real world conditions
- Understand scalability and wider use of electric buses on other routes, and full electrification of routes
- Understand scalability and wider use of wireless charging solutions on other routes
- The necessary tools to inform strategy going forward, procurement methodology, and framework agreements
- Sustainability

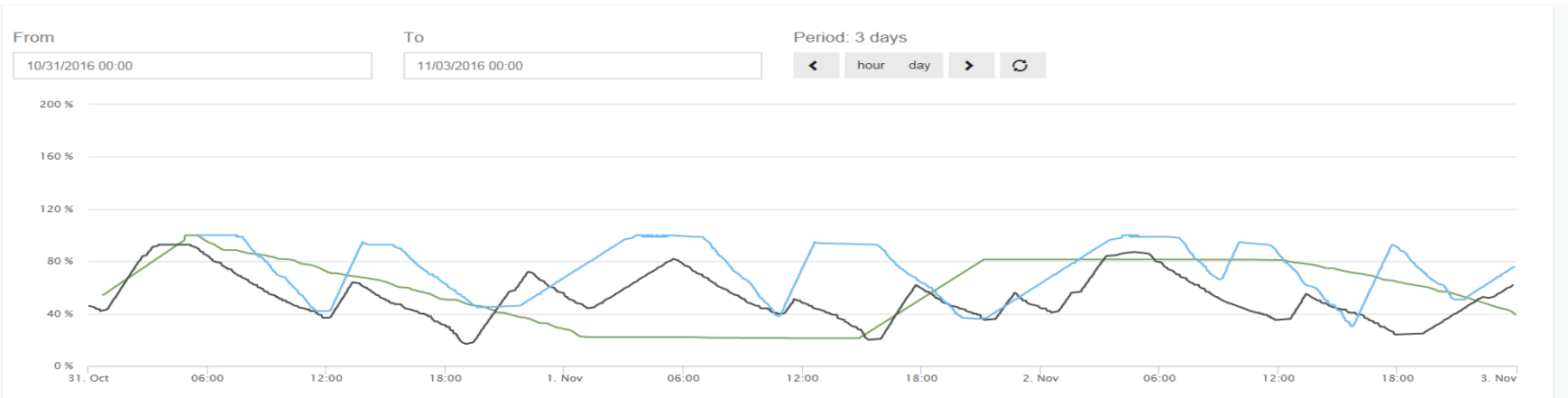
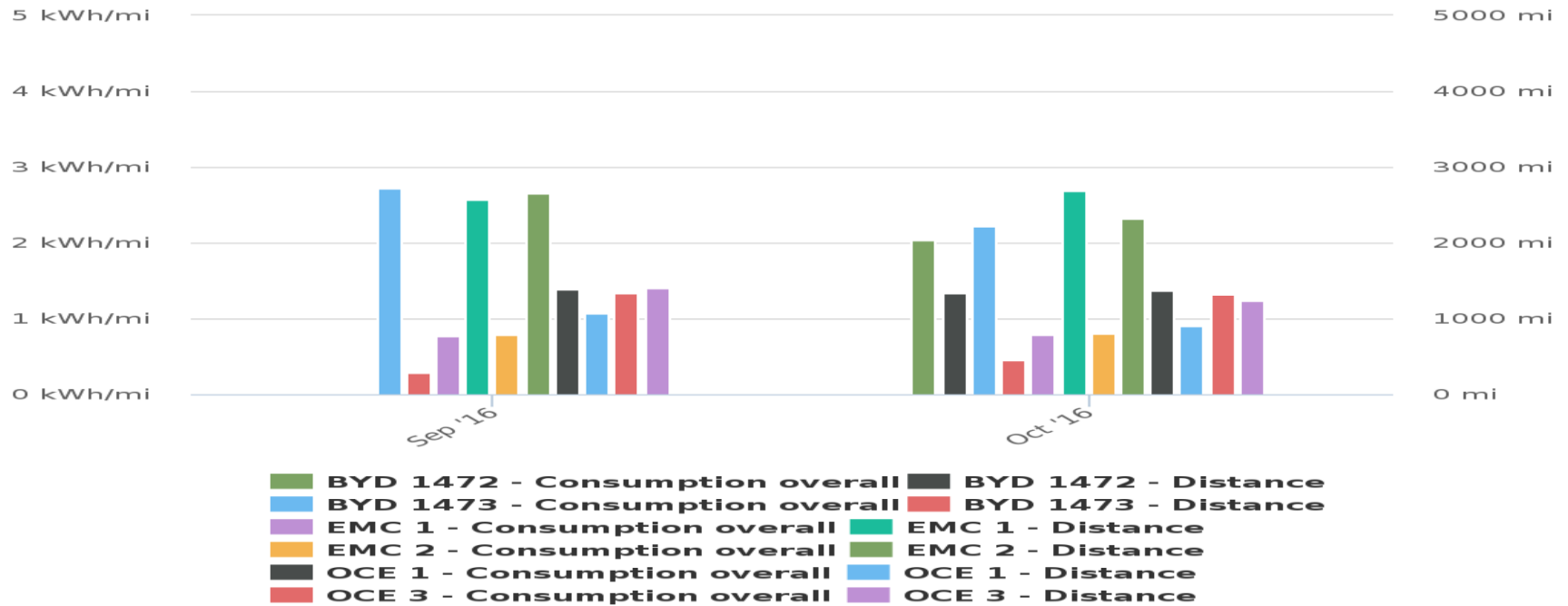


Electric Bus Trials

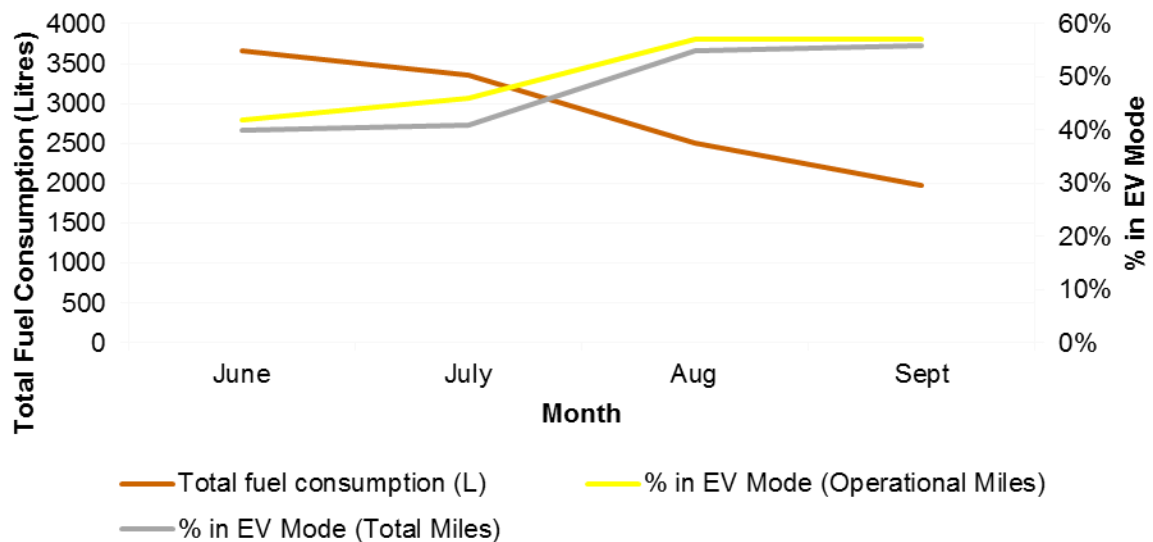
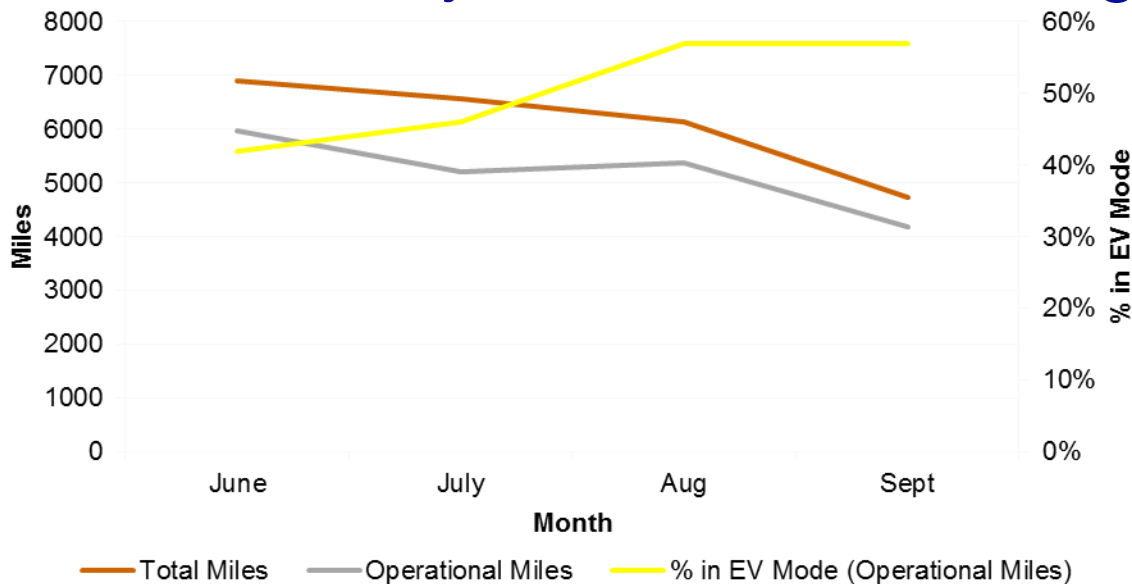
- The first two BYD buses went into service on route 507 and 521 - December 2013.
- Four Optare Metrocity buses entered service on route H98 - May 2014.
- Two Optare Metrocity vehicles entered service on route 312 with Arriva in December 2014. A further seven Optare Metrocity buses went into service Sept 2015.
- Two Irizar i2e buses entered service on route 507/521 with Go Ahead during August 2015.
- New E200 entered service on routes 507/521 – July 2016, a total of 51 buses will be in service by the end 2016.



Performance Data



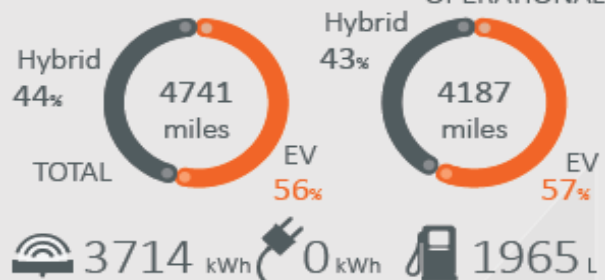
ZeEUS Project - Wireless Charging Bus Trials



ZeEUS Monthly Report

Summarising the key results from TRL's analysis of London demonstrations of inductively charged electric buses.

OVERVIEW

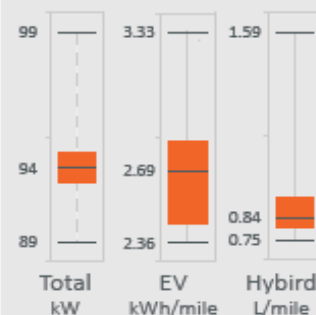


CONSUMPTION Per Mile

EV	2.40 kWh
HYBRID	8.10 kWh (0.81 L)
COMBINED	4.93 kWh
REF*	10.0 kWh (1.00 L)

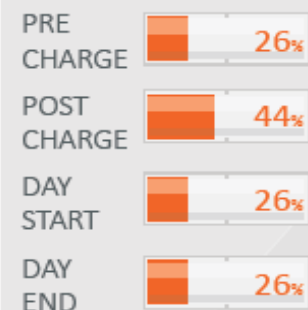
*Ref bus (Euro IV with CRT)

DRIVER EFFECT



BATTERY STATUS

Average state of charge



WIRELESS CHARGING

*Per Charge Event (Average)

OVERALL

CHARGE TIME*	9.72 mins
ENERGY TRANSFER*	16.01 kWh

WALTHAMSTOW

CHARGE TIME*	10.16 mins
ENERGY TRANSFER*	15.74 kWh

CANNING TOWN

CHARGE TIME*	11.45 mins
ENERGY TRANSFER*	16.30 kWh

Walthamstow IPT charger appears to be much more heavily used, with approximately 147% more energy delivered to buses during the month than Canning Town.

BY VEHICLE

	SN65 ZGO	SN65 ZGP	SN65 ZGR
Total Distance (miles)	812	2395	1534
Average IPT Power (kW)	98	99	98

99.29% of time spent in Geo-Fenced areas*, the buses were running in EV mode.

*end of route bus stations

NOTES

- Overall 25% of the total bus data had driver ID associated: No driver ID for bus 2.
- There were approximately 757 layover stops during the month for all three buses. Only 31% of the layover stops had a charge event (242 charge events across all three buses)
- There was no overnight plugin charging. Both wireless chargers were operational.

Charging Infrastructure

- Operators bid for the entire cost of running a route – includes charging infrastructure
- Opportunity charging during the day – optimising range/cost/weight vs charging infrastructure – route dependant
- Power supply upgrades required
- Smart charging to manage overnight charging power demands, charge vehicles dependent on SOC and run out
- Space and safety requirements in some garages may mean over-head gantries, pantograph,
- Potential to connect to high voltage London Underground network at certain locations



Regulatory Framework

Enhanced TfL Bus Standards (facilitate new and emerging technologies)

Planning consent

Distribution Network Operator (DNO) Compliance, Installation standards (Harmonics)

DNO capacity/upgrades & timescales long lead times, confirmed orders, no speculative upgrades

EMC and EMF standards to meet rail standards, when adjacent to existing rail infrastructure



Standardisation

- Develop bus specification documents
- Common Standards
- Future proofing charging infrastructure
- Develop policy documents
- Interoperability to move buses around the network
- Energy supplier
- Develop standard framework agreements

