10 NOVEMBER 2016

London Underground: Opportunities for bus electrification?

Mark Poulton
Vehicle Technology Manager

EVERY JOURNEY MATTERS

Contents

- Introduction and context
  - Transport in London
  - London's challenges
- TfL's role in eLIPTIC
  - Use Cases
- London Underground's power network
  - History of the LU network
  - Improving energy efficiency
- Future of transport electrification
  - Strategic relevance of eLIPTIC
 - Energy challenge


EVERY JOURNEY MATTERS

Transport in London

- Transport for London (TfL) manages London's integrated transport system

- Each weekday across Greater London, more than 30 million transport trips are made –

  - 6.5 million journeys on London's buses

  - 4.5 million on the Underground

  - 6 million on foot

  - 0.6 million by bicycle

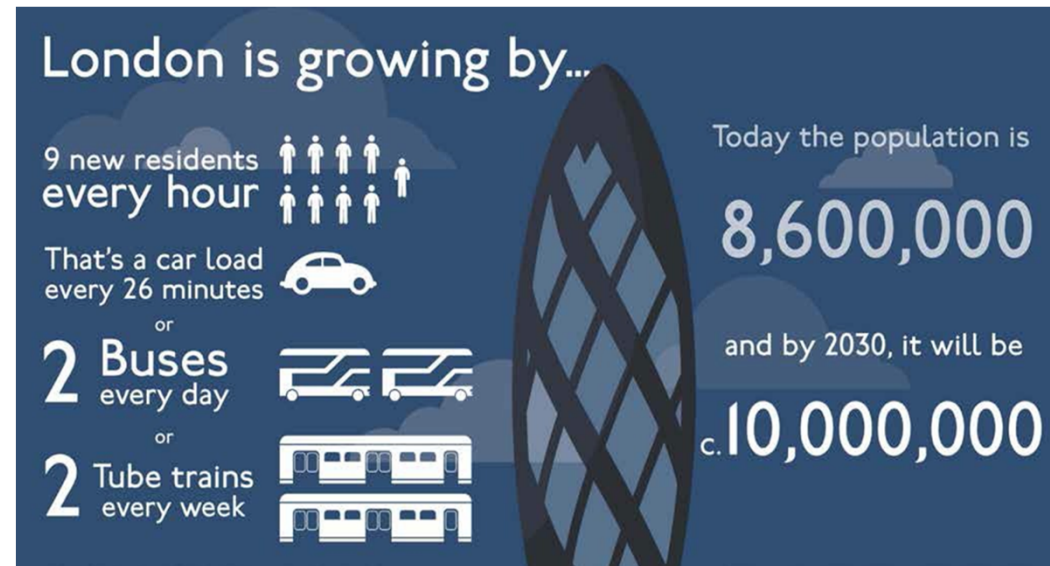 - 0.2 million by taxi

  - 12 million by car & motorcycle

TRAMS

UNDERGROUND   AIR·LINE   BUSES   COACHES

ELIZABETH LINE   CYCLES   DIAL·A·RIDE   D L R

OVERGROUND   RIVER   TAXI·PRIVATE HIRE   TFL·RAIL

EVERY JOURNEY MATTERS

London's challenges: environment

- Air quality – NO_2 (and PM_{10} & $PM_{2.5}$)

- Poor air quality is known to cause respiratory and cardiovascular conditions and is linked to around 9,400 premature deaths p.a. in London

- Road transport contributes 80% of PM and 63% of NOx emissions in London

- Target to reduce London's CO_2 emissions by 60% by 2025

- Ambition for 'Zero Carbon' by 2050

EVERY JOURNEY MATTERS
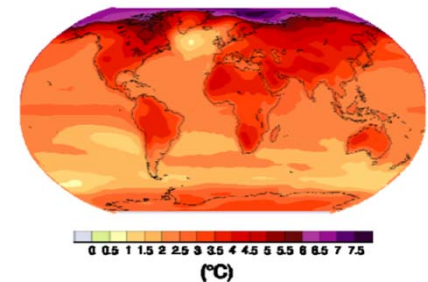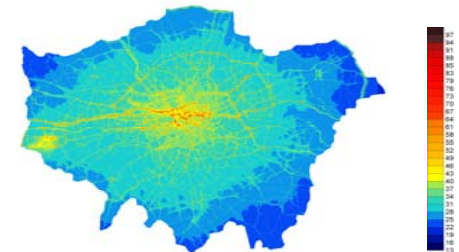
London's challenges: growth

- Population growth – transport capacity
- Congestion (space for more active travel)
- Road safety

London is growing by...

9 new residents every hour

That's a car load every 26 minutes

or

2 Buses every day

or

2 Tube trains every week

Today the population is

8,600,000

and by 2030, it will be

c.10,000,000

EVERY JOURNEY MATTERS

Mayor's transport priorities

- Proposals for cleaning London's air will achieve compliance with limits for NO_2 by 2025

- Further action will be required to allow London to become a zero-carbon city by 2050

- Encouraging the use of EVs where road vehicles are needed is key to reducing transport emissions

- All new vehicles should be zero emission by 2040 in order to achieve the 2050 goal
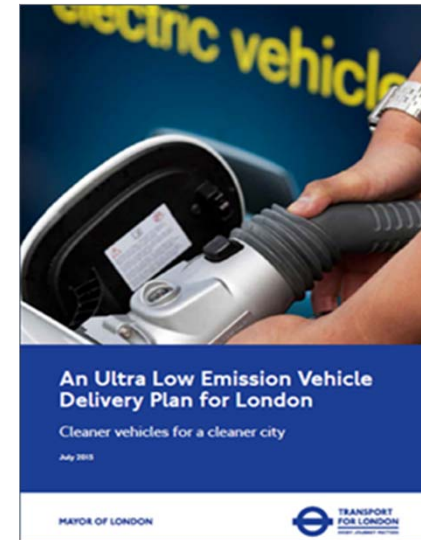
EVERY JOURNEY MATTERS

TfL is using its influence to increase all types of ULEVs on London's streets

New licencing requirements for zero emission capable taxis and Private Hire Vehicles

An Ultra Low Emission Vehicle Delivery Plan for London
Cleaner vehicles for a cleaner city
July 2015

MAYOR OF LONDON   TRANSPORT FOR LONDON

LoCITY programme to help the freight industry adopt ULEVs

Supporting innovation through Mayor's Air Quality Fund
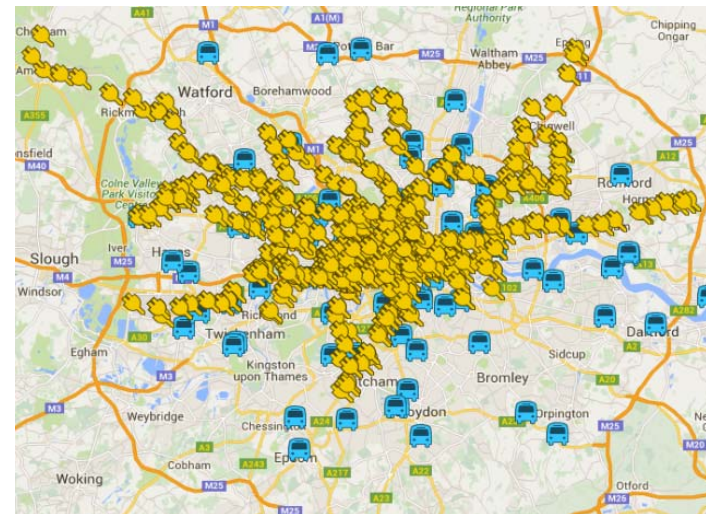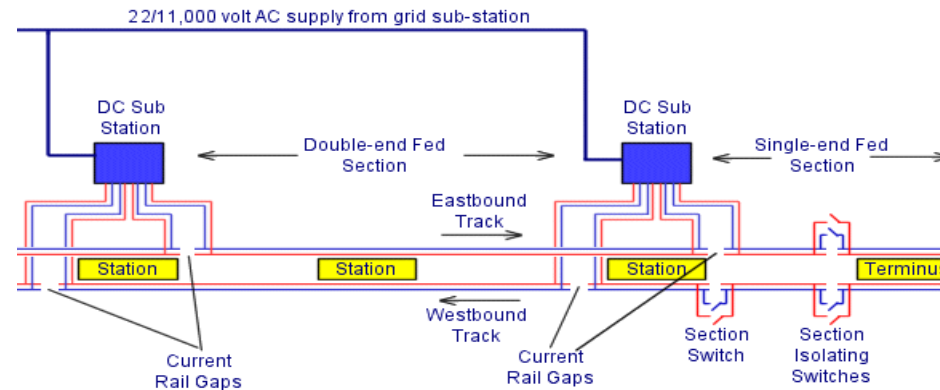
EVERY JOURNEY MATTERS

TfL and eLIPTIC: Use Cases

- Key aim: study of the London Underground energy system and London bus networks

- Identifying potential locations for access to the power network to charge electric buses (Pillar A)

- Other plug-in vehicles also of interest (Pillar C)

EVERY JOURNEY MATTERS
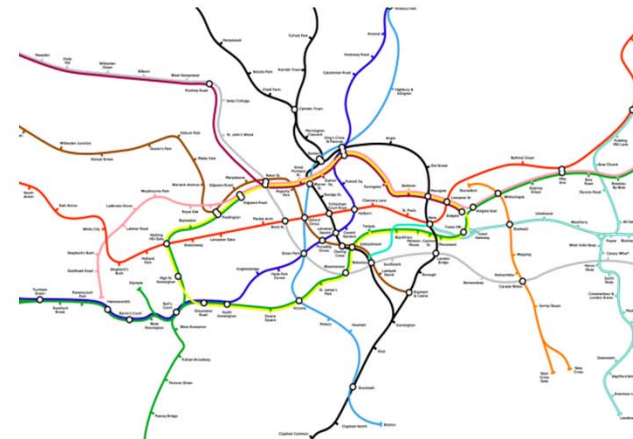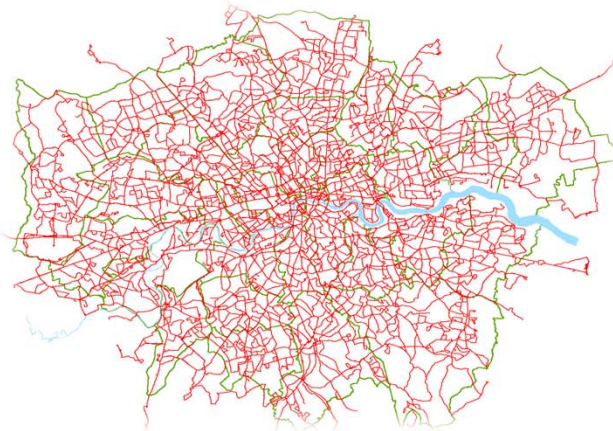
TfL and eLIPTIC: practical considerations

- Spatial (co-) location

- Cost effectiveness

- Legal, regulatory & commercial issues

- Analysis of demand patterns and available capacity

- Suitability of bus route conversion to plug-in vehicles

- Trial or pilot connection to quantify impacts on LU network

EVERY JOURNEY MATTERS

London Underground's power network

Collection of
London Transport Museum
www.ltmcollection.org

City & South London Railway

Original Line 1890
Extensions of 1900 and 1901
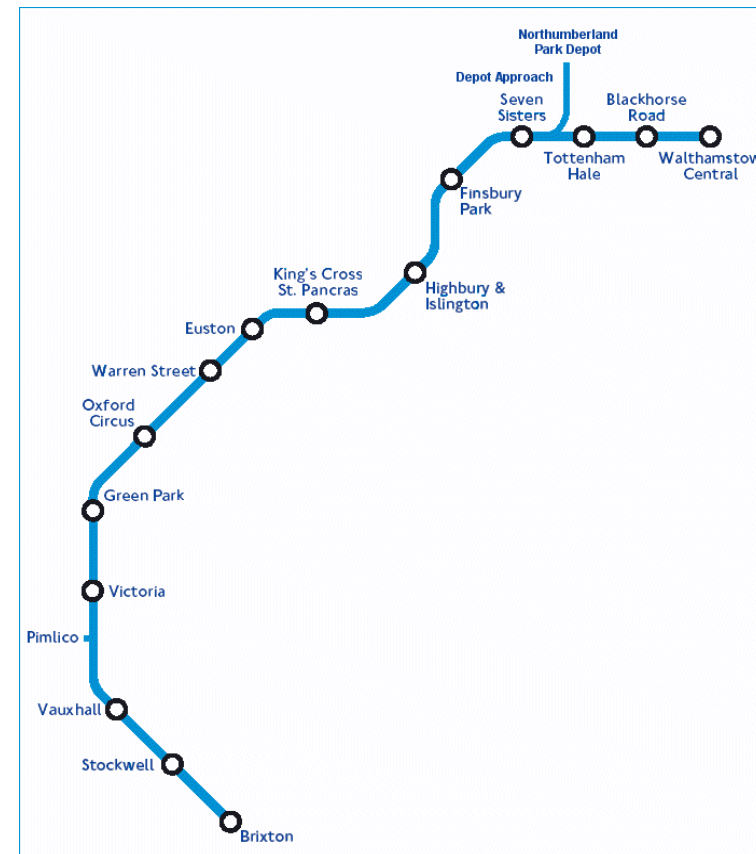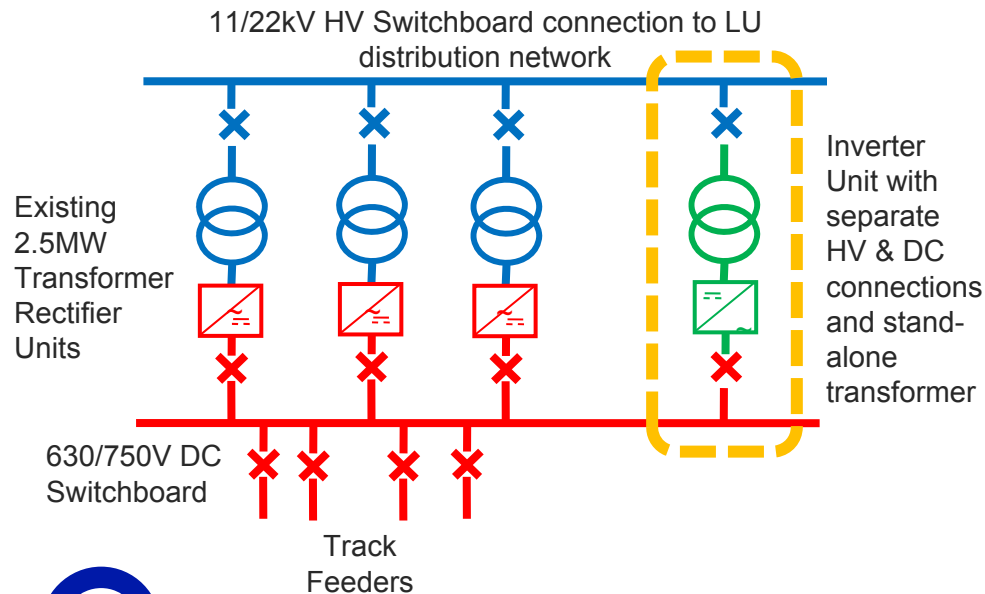
EVERY JOURNEY MATTERS

London Underground's power network

- Over 1 TWh traction energy consumption p.a.

- Energy costs > £100m p.a.

- Transmission & distribution charges rising

- Energy efficiency projects include regenerative braking energy recovery

- Understand benefits of energy storage / load shifting

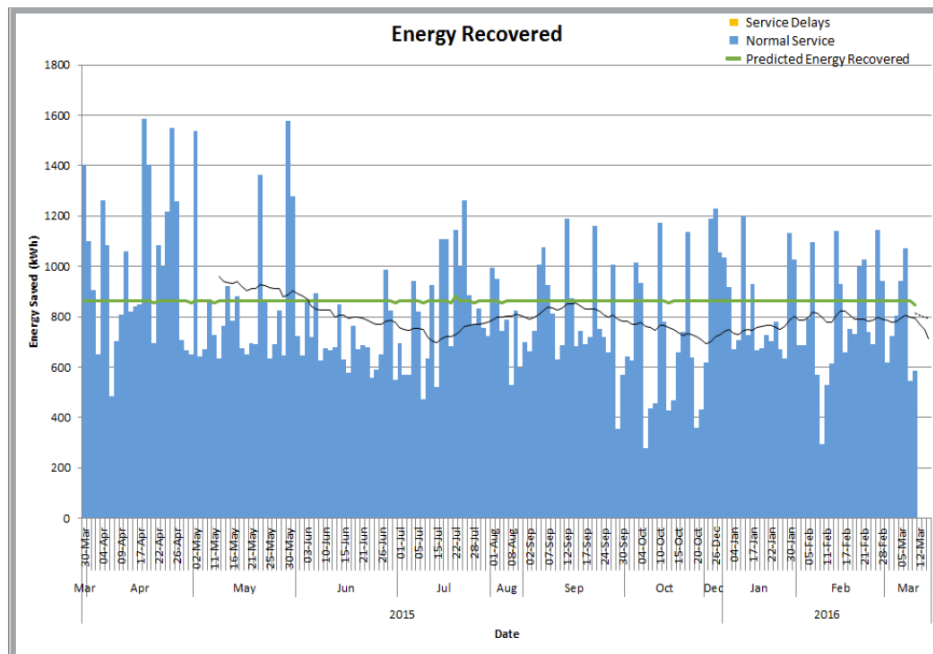- Sourcing more low carbon, decentralised energy

EVERY JOURNEY MATTERS

LU traction energy efficiency

- Victoria Line: annual energy consumption ~ 80 GWh

- Trial of inverting substation to capture otherwise wasted energy

11/22kV HV Switchboard connection to LU distribution network

Existing 2.5MW Transformer Rectifier Units

630/750V DC Switchboard

Track Feeders

Inverter Unit with separate HV & DC connections and stand-alone transformer

EVERY JOURNEY MATTERS

LU traction energy efficiency

- Circa 5% traction energy recovered
- Results have validated simulation

EVERY JOURNEY MATTERS
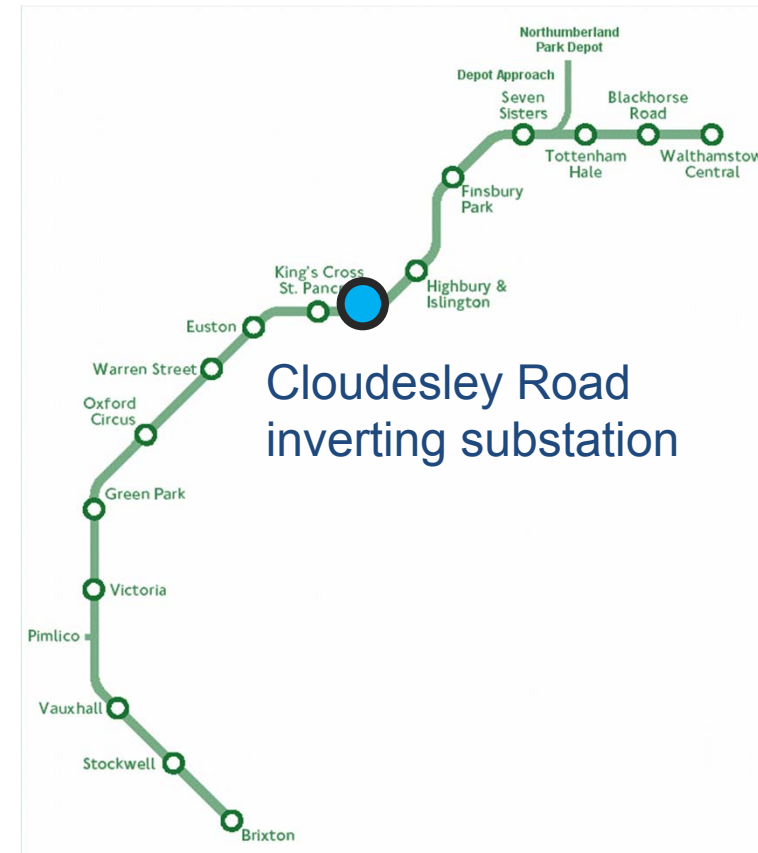
LU traction energy efficiency

- Almost 1 MWh per day saved on average on one DC section
- Role for energy storage?
- Possible link to surface transport electric vehicles?
- 1 MWh ≈ energy consumed by 4 or 5 electric buses
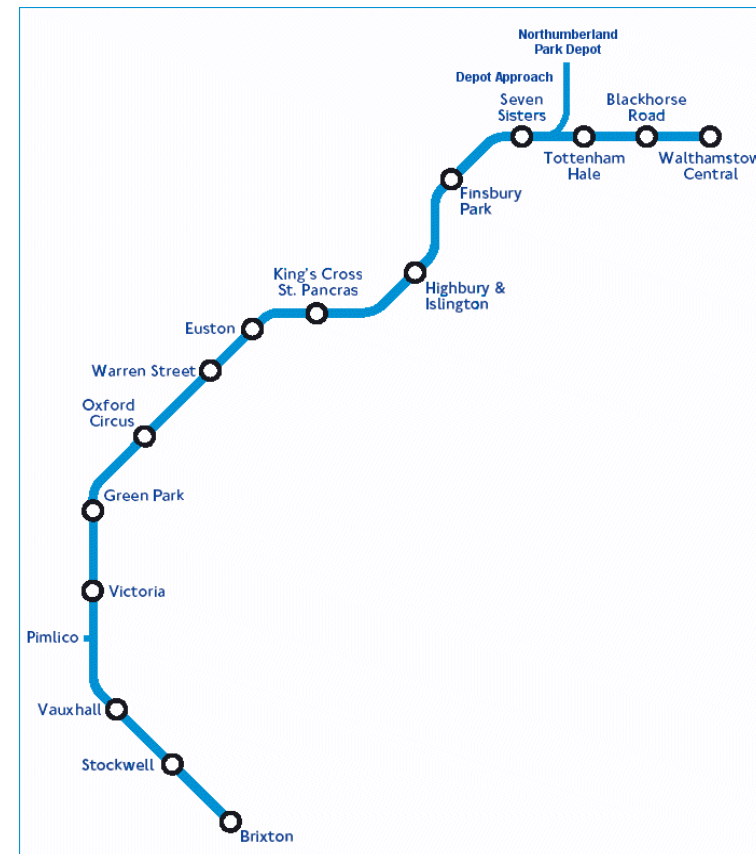
TfL and eLIPTIC: strategic relevance

- Future role of a smart HV network, supporting London's future energy needs

- Integration of energy storage & dynamic energy management (DSR, V2G)

- New value chains?

- Co-location of existing energy infrastructure with spatial demands for future EV charging networks

EVERY JOURNEY MATTERS
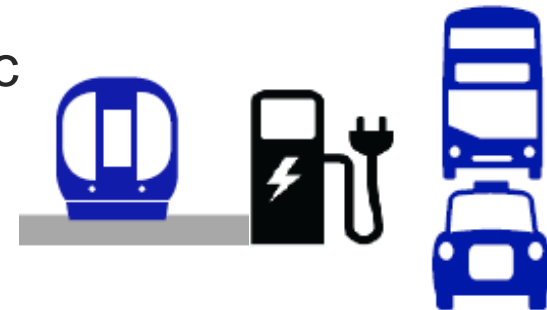
Electrification of London's transport: future energy needs

Mode or means of transport	Passenger journeys / vehicles	ENERGY consumption* p.a.	Maximum POWER consumption
London Underground	4.5 million / day	1.1 TWh (1,100,000,000 kWh)	~ 250 MW
London Buses	6.5 million / day 9,000 buses	~ 750 GWh	~ 250 MW (⅓ fleet charging @ 80kW)
Taxis & Private Hire	22,000 taxis > 80,000 PHVs	~ 750 GWh	Almost 10 times London Underground's annual traction energy consumption
Commercial fleets	1,200 – TfL fleet > 220,000 LGVs reg'd in London	~ 10 GWh ~ 2.4 TWh	
Private cars	~ 2.6 million	~ 5 TWh	

* Energy consumption data for surface transport modes are estimated and provided to illustrate the broad scale of future needs. These are based on today's fleet and mileage, and do not account for potential future changes in composition, usage etc.

EVERY JOURNEY MATTERS

For more information contact:

Mark Poulton

Vehicle Technology Manager

markpoulton@tfl.gov.uk

EVERY JOURNEY MATTERS