

# BYD: Electric Buses for the UK



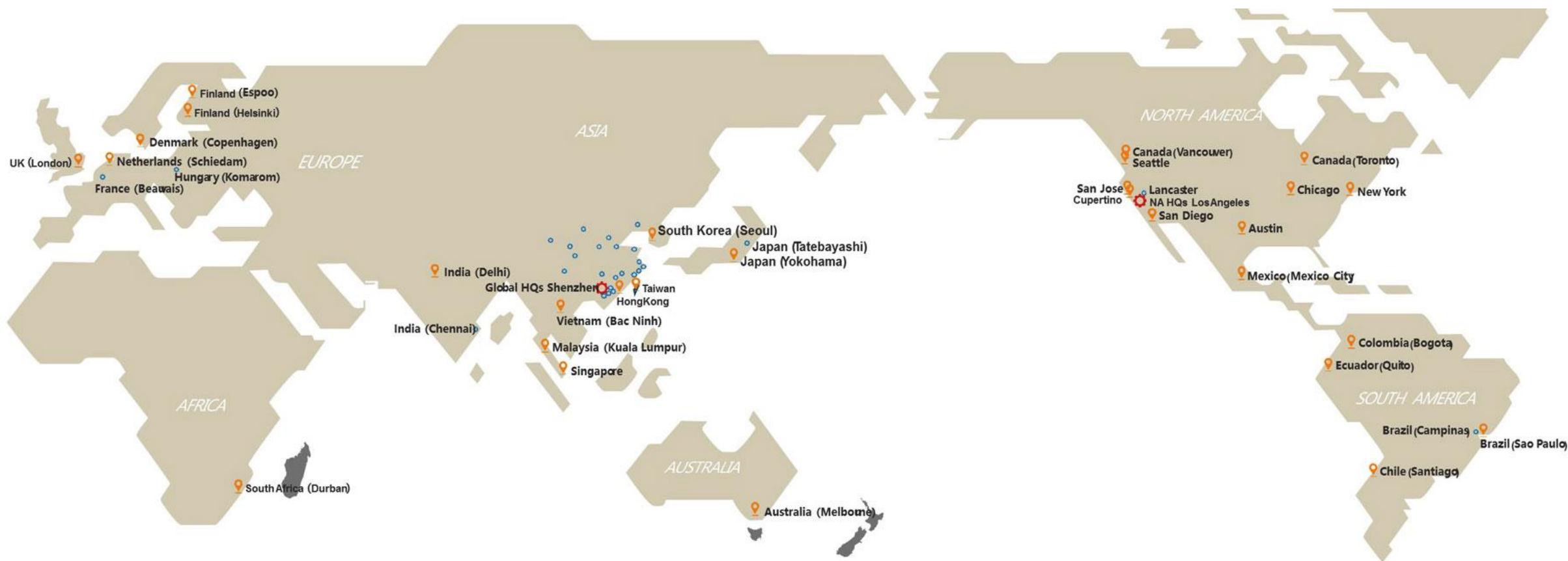
- 1995 – Founded as a lithium-ion battery developer / manufacturer
- 2002 – Listed on Hong Kong stock exchange
- 2003 – Vehicle manufacture starts
- 2008 – Warren Buffett’s Berkshire Hathaway Inc. acquires 10% share in BYD for \$230m
- 2010 – Joint venture with Daimler AG to develop Denza electric car brand for Chinese market
- 2016 – Samsung acquires 2% share in BYD for \$449m
- 2016 – Europe’s biggest single electric bus fleet (51 buses) delivered to Go Ahead London
- 2017 – First European bus assembly plant opens in Komarom, Hungary (capacity up to 400 units per year)
- 2017 – Total annual BYD bus production 14000 units
- 2018 – Second European bus assembly plant opens in Beauvais, France (capacity up to 200 units per year)
- 2019 – 50000<sup>th</sup> BYD electric bus built

Now the world’s largest manufacturer of rechargeable batteries and new energy vehicles, and a leading-edge provider of Green Energy Technologies. 13% of global electric car and van market; over 20000 electric buses delivered – 27% market share in Europe with 129 buses delivered by June 2017. Monorail system launched in 2016. Revenues of €13.58 billion (2017).

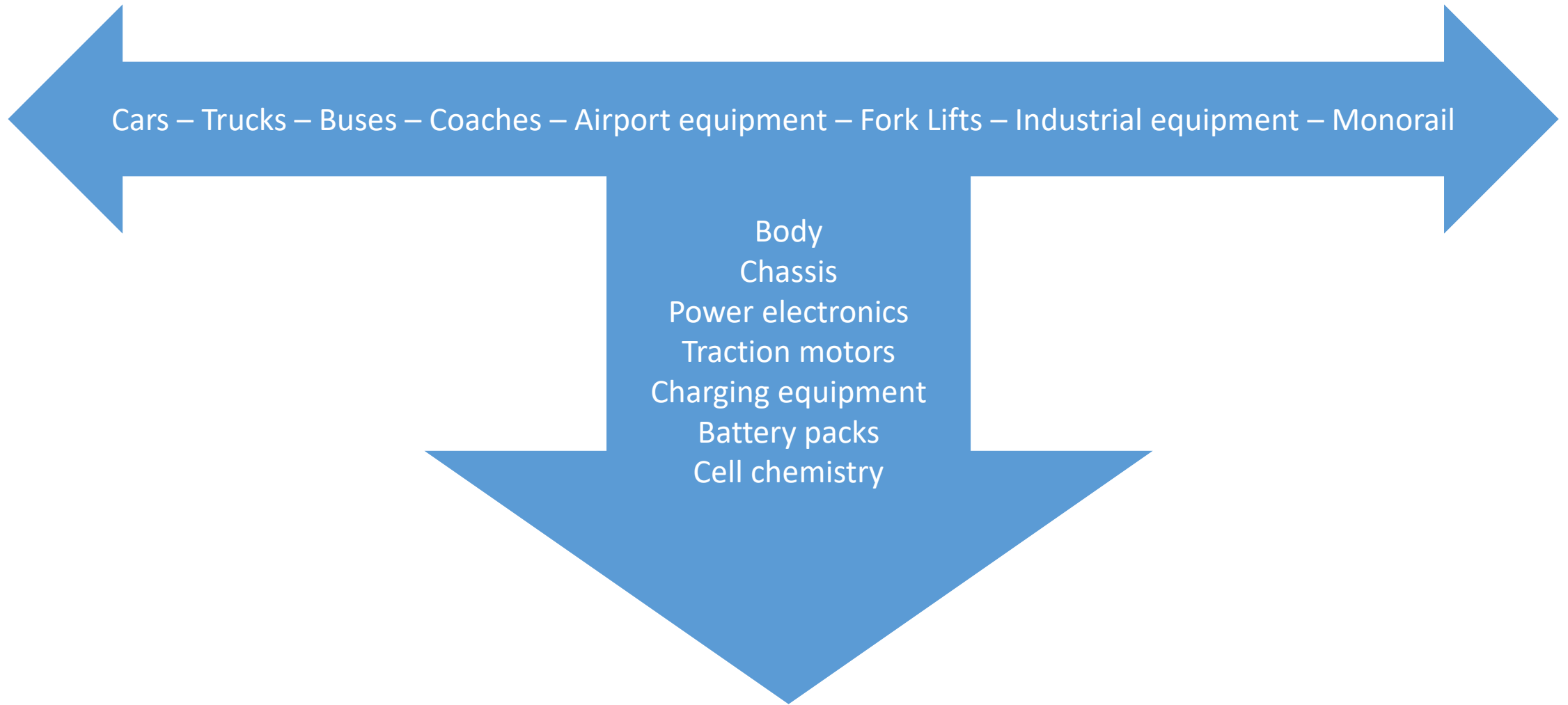
# Global Reach



**33** Manufacturing Sites, **27** Branches



# Breadth and Depth



# Wide Global Product Portfolio





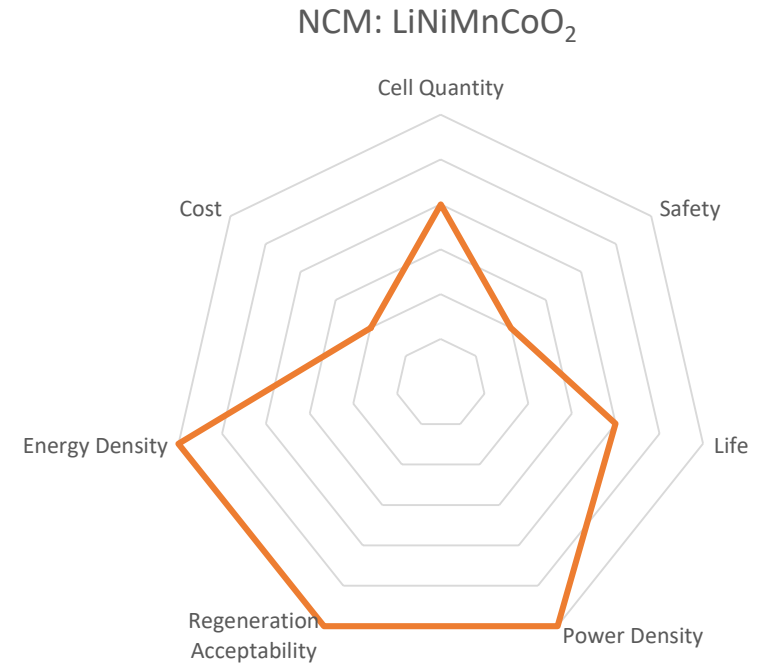
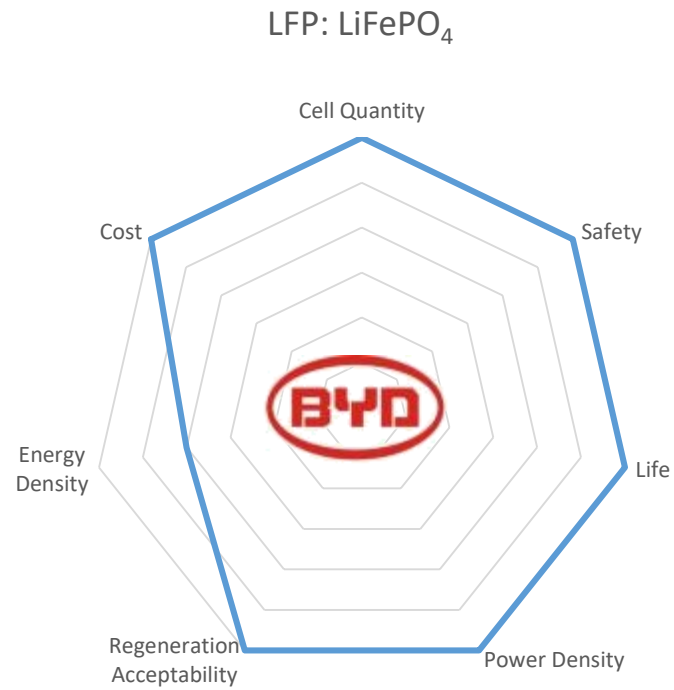
# Battery Technology



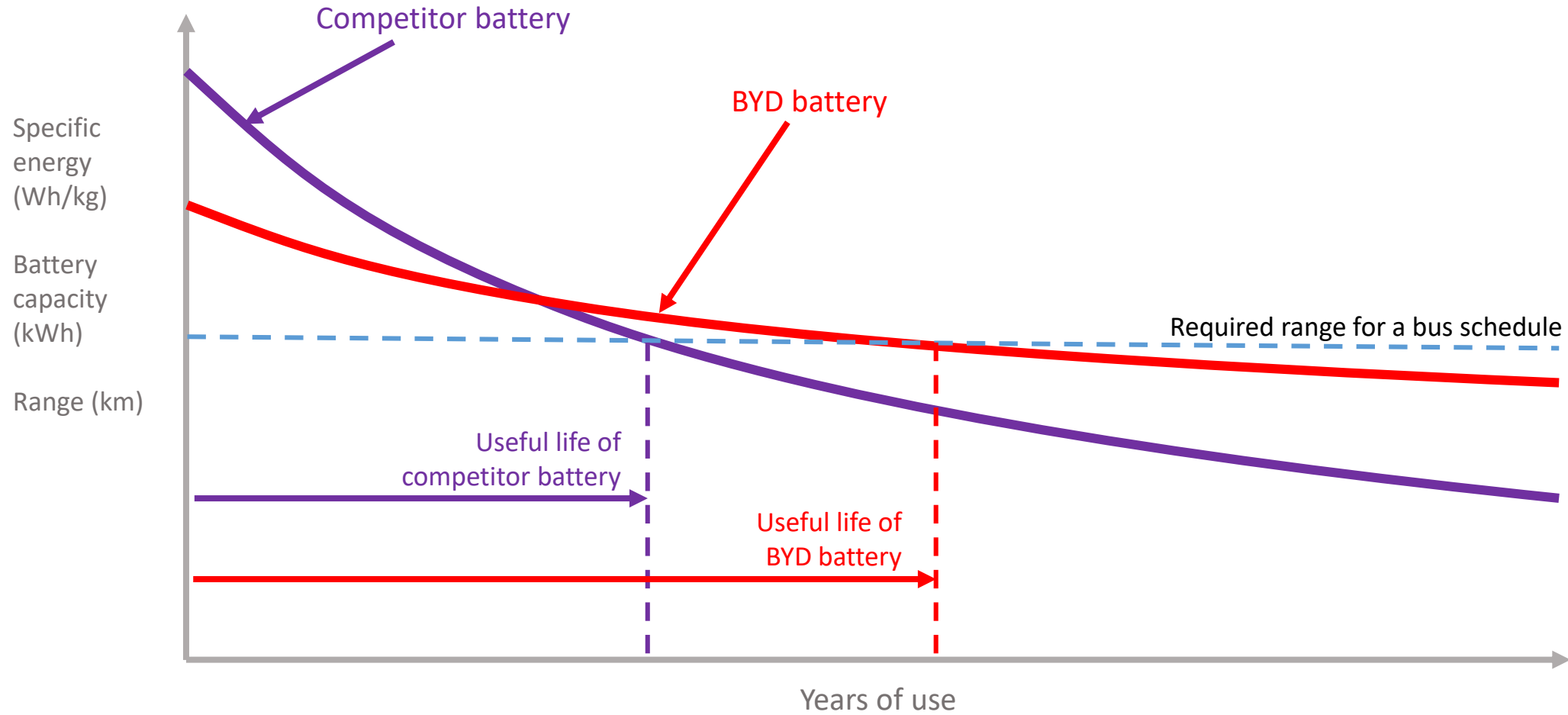
- World leader in lithium battery development and manufacture
- Three battery factories with combined capacity of around 28 GWh per year
  - *Planned increase to 60 GWh per year by 2020*
- Highly automated processes



# Lithium Cell Chemistries



# Capacity and Cycle Life







# European Facilities



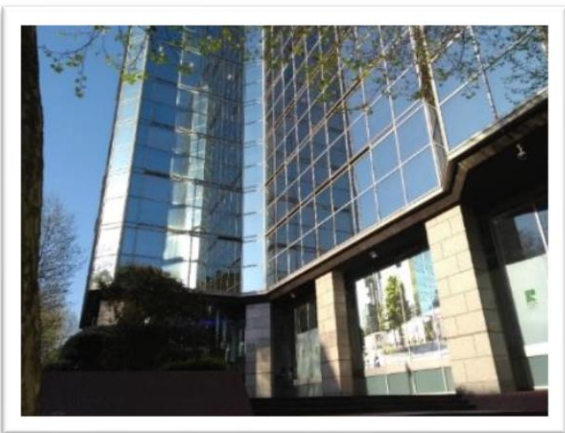
European headquarters, Rotterdam



Bus assembly plant, Hungary: opened 2017



Bus assembly plant, France: opened 2018



London office: opened 2016



UK Service Centre, Iver: opened 2018



# UK Bus Strategy

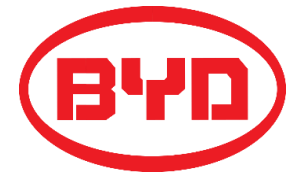


- Partnership with Alexander Dennis
  - Leveraging ADL's market knowledge and body capabilities*
- 12m, 10.8m and 10.2m single deck already available
- BYD/ADL double deck starting deliveries into London
  - Following successful field trials of five BYD bodied electric double deckers in London*
- 9.6m derivative available later in 2019

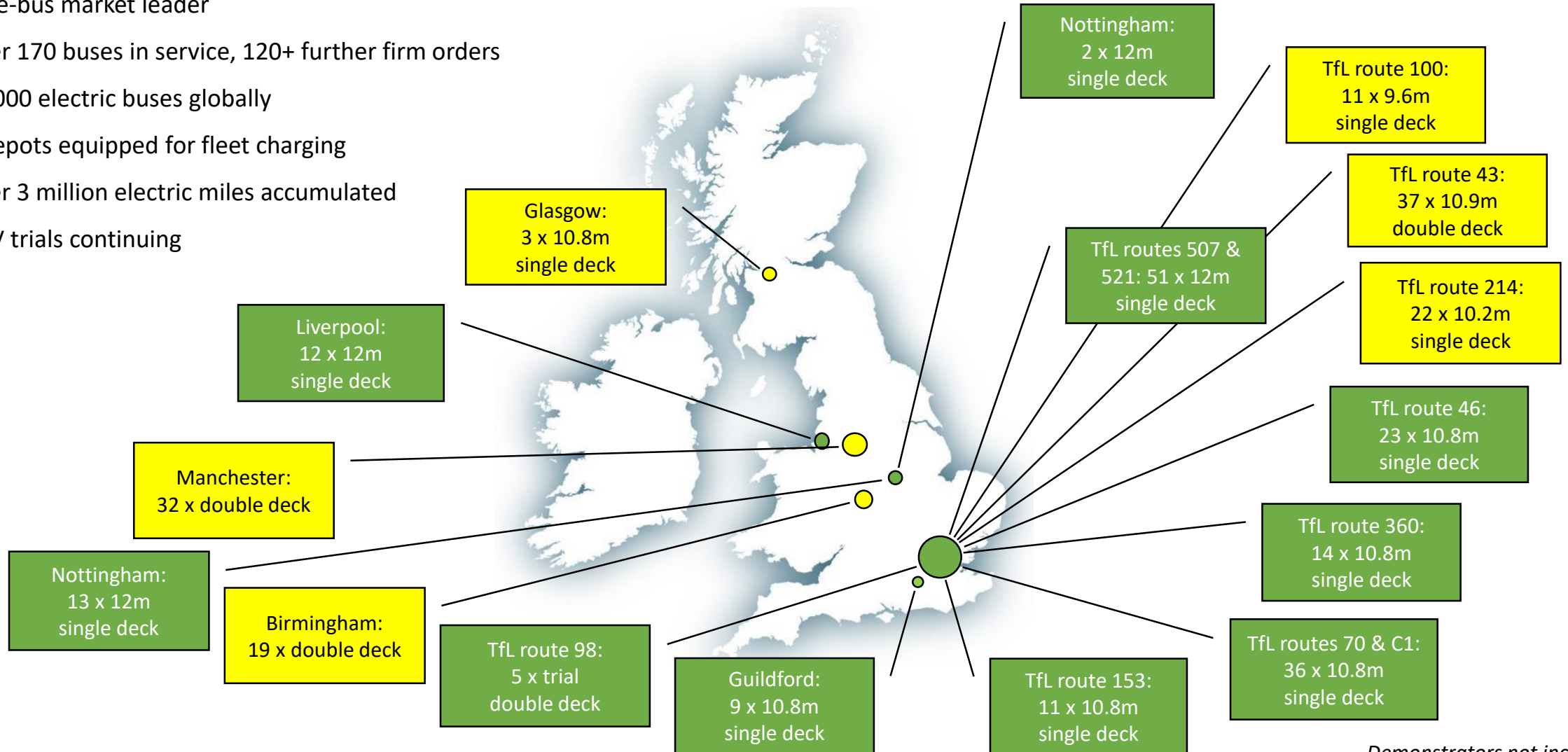




# Achievements to Date



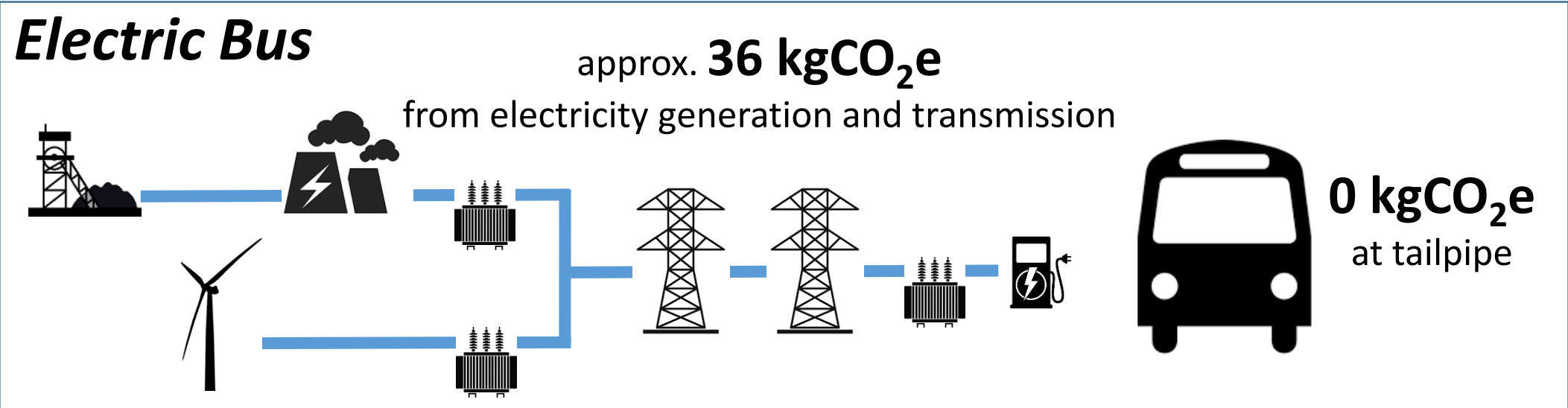
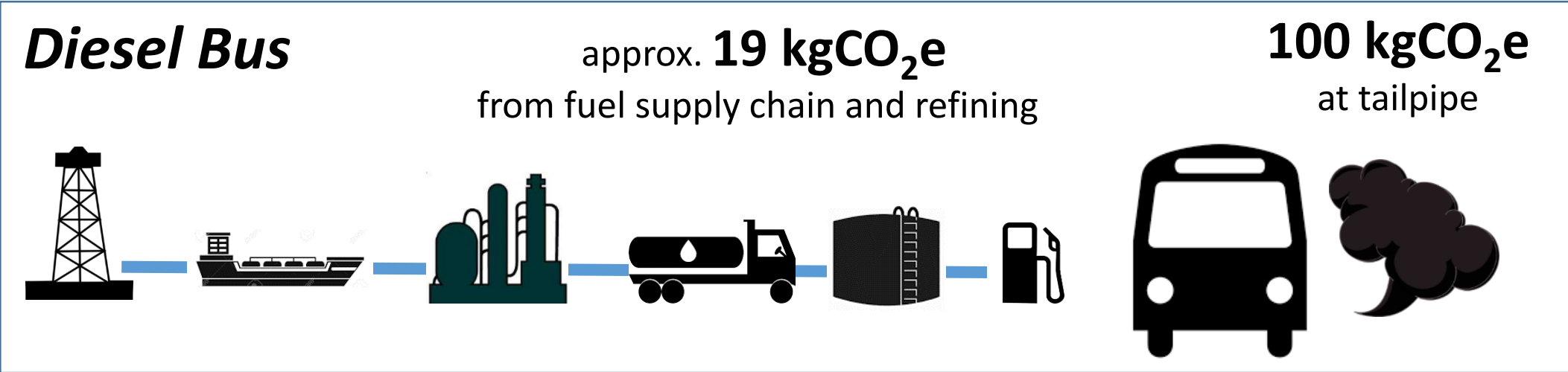
- ✓ UK e-bus market leader
- ✓ Over 170 buses in service, 120+ further firm orders
- ✓ 50 000 electric buses globally
- ✓ 8 depots equipped for fleet charging
- ✓ Over 3 million electric miles accumulated
- ✓ PHV trials continuing



*Demonstrators not included*



# Environmental Impact



**60-70%  
Overall  
Saving**

Based on UK grid and fuel supply, typical figures

# AC Charging



- Compact, low cost chargers
- Facilitates a charger for every vehicle
- Can be managed across a site by a local network control system
- Can log charging events and energy consumption vehicle-by-vehicle
- Potential for V2G or V2V

Dimensions	mm (L/W/H)	400 x 200 x 690
Weight	kg	30
Voltage	V	400 (3 phase)
Max power	kW	40 x 2
Max current	A	126
IP rating		IP65
Cable length options	m	3 (standard) 5 (option)
Plug configuration		Twin plugs

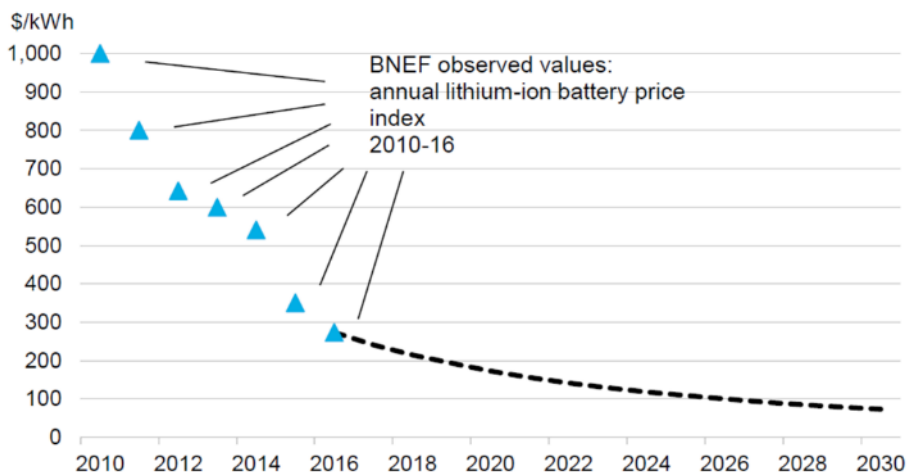
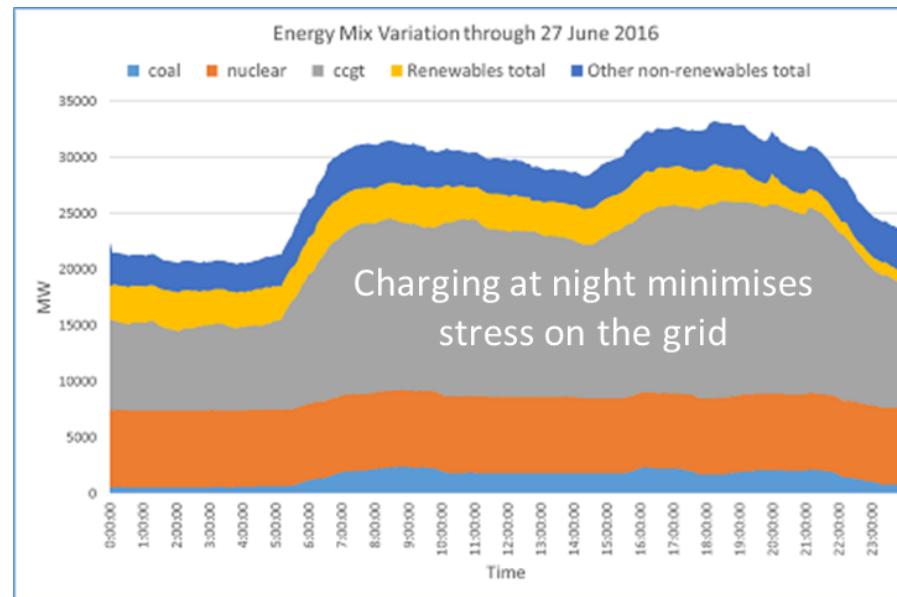




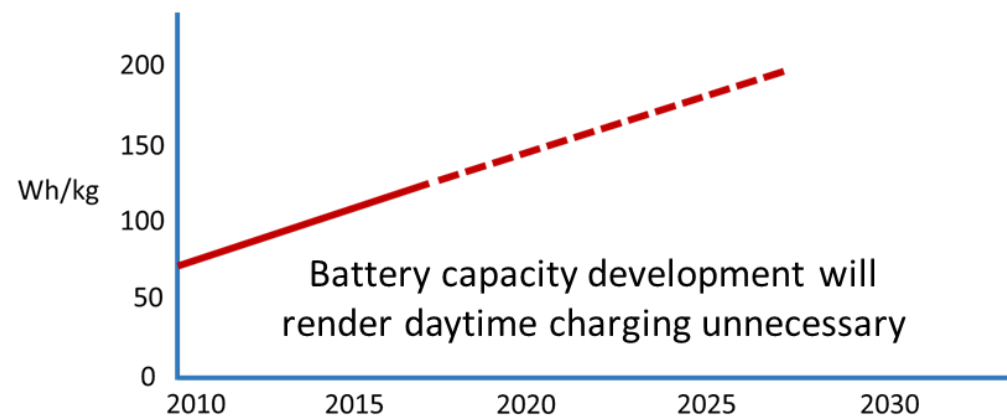
# Overnight Charging

## Overnight charging will become the dominant strategy for electric buses

- Charging infrastructure installations are quicker, cheaper and safer to deploy at bus garages than public-realm locations.
- Public-realm locations (bus stations, bus stands, etc) are usually very space constrained.
- Night-time charging avoids electricity use during peak demand times and has a lower carbon signature.
- Minimal impact on bus schedules.
- Much lower cost per charger.
- More flexibility in charging time management.
- Fewer battery cycles per year, giving increased battery life.
- Higher charging efficiency – the losses during 300kW charging would be about 14 times higher than for 80 kW charging on an equivalent battery.
- Lowest possible C-rates – which will significantly improve cell life.



Source: Bloomberg New Energy Finance



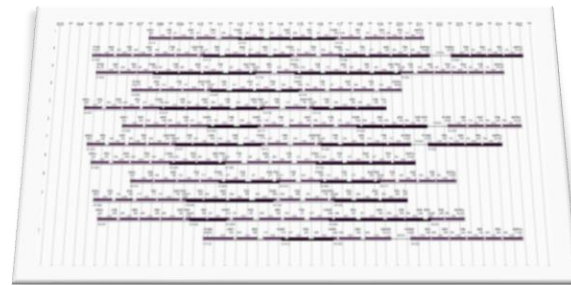


# Electrification Planning and Project Delivery



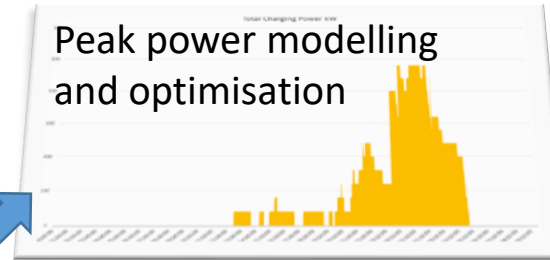
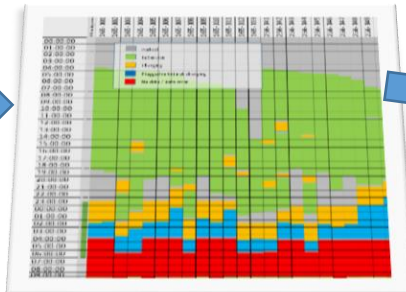
- Schedule assessment
- Energy modelling
- Demonstrator loans
- Charging strategy recommendations
- Parking layouts

- Liaison with infrastructure partners
- Project management and coordination



Route schedule

Battery utilisation modelling



Peak power modelling and optimisation

Electricity use predictions

total distance km	5744.
total drive time (decimal hours)	351.
total energy used kWh	5169.
total energy into battery kWh	5169.
total energy at point of supply kWh	5619.
percentage off peak energy	71.6%
peak power to garage MW	0.9



Charging Management System definition



Charger installation proposals

Parking layouts



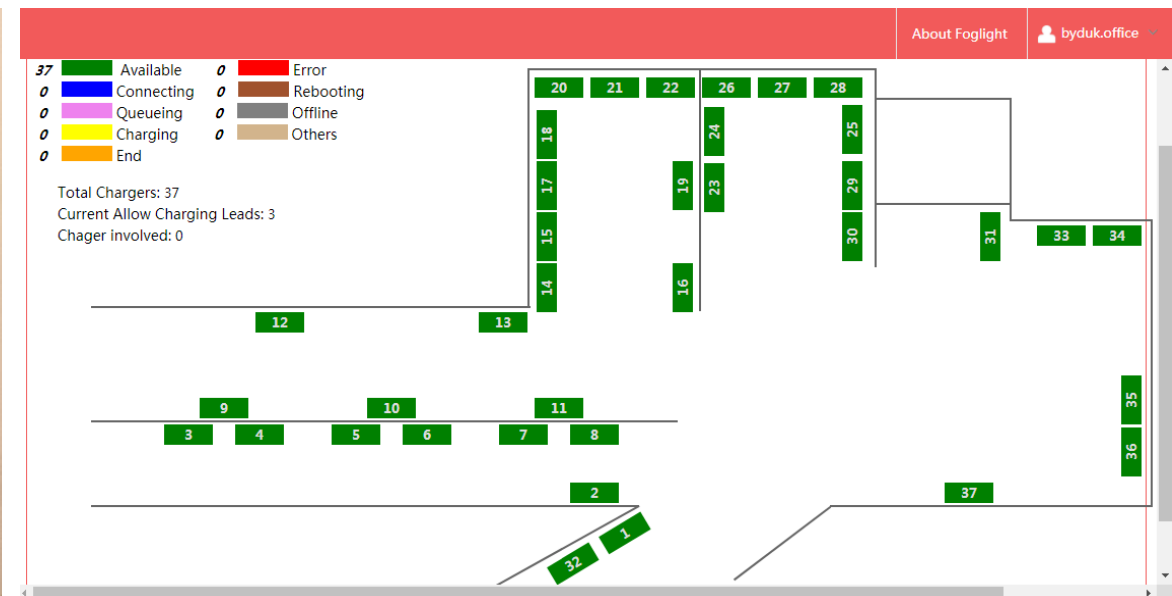
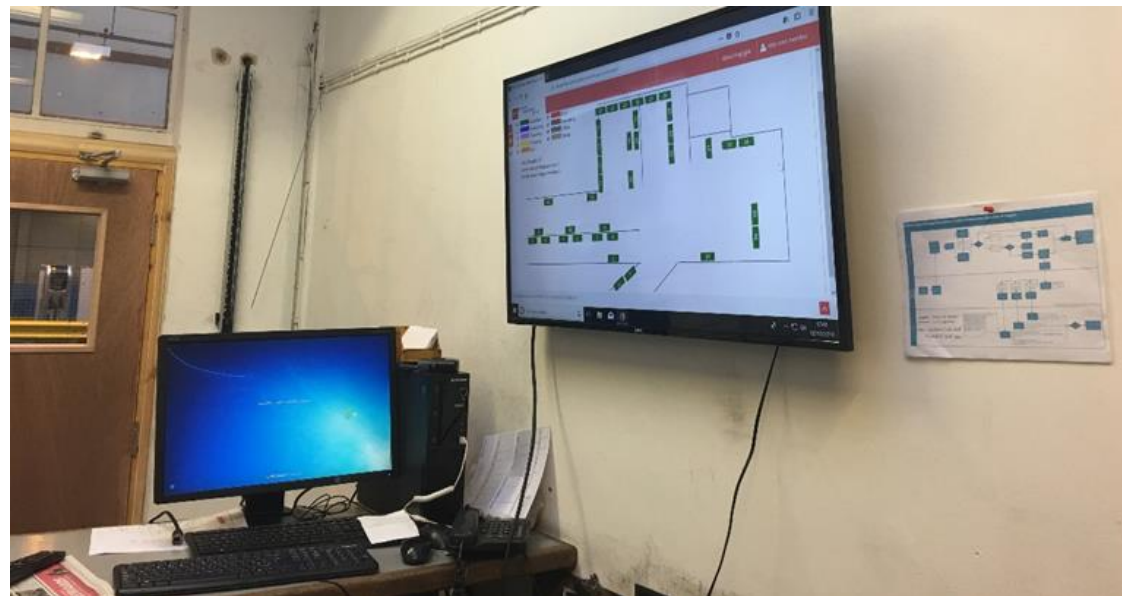
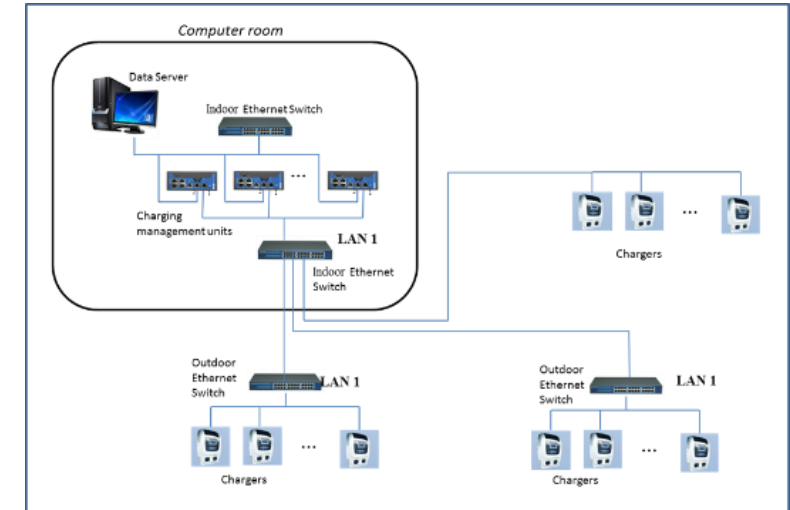
Vehicle orders

Site works



# Charging Management System (CMS)

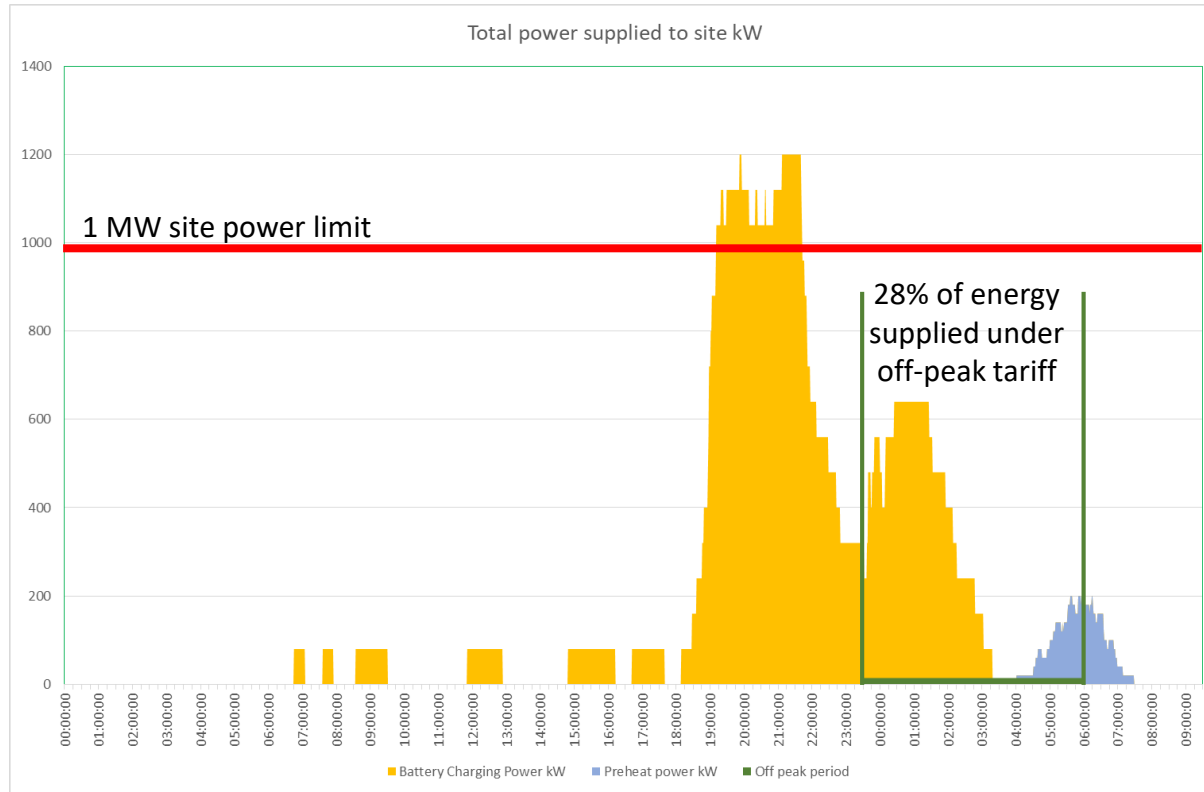
- All chargers at a depot managed by a local control network
- Site power constraints can be set, variable by time-of-day
- Priority levels can be set for each charger (e.g. according to run-out sequence)
- Buses with very low state-of-charge can automatically queue-jump
- Real-time status display
- Automatic email alerts in the event of major faults
- Statistical reporting



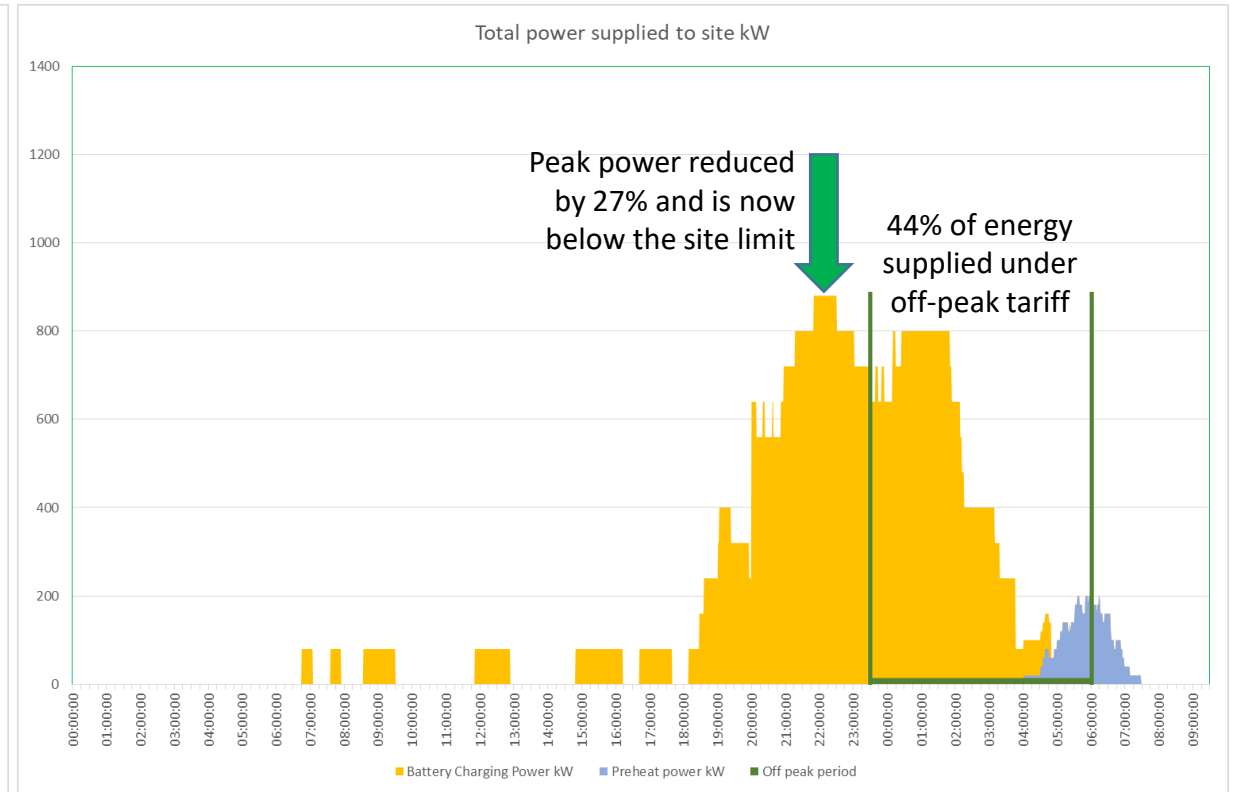
# CMS: UK Urban Bus Fleet Example



## Charge on arrival



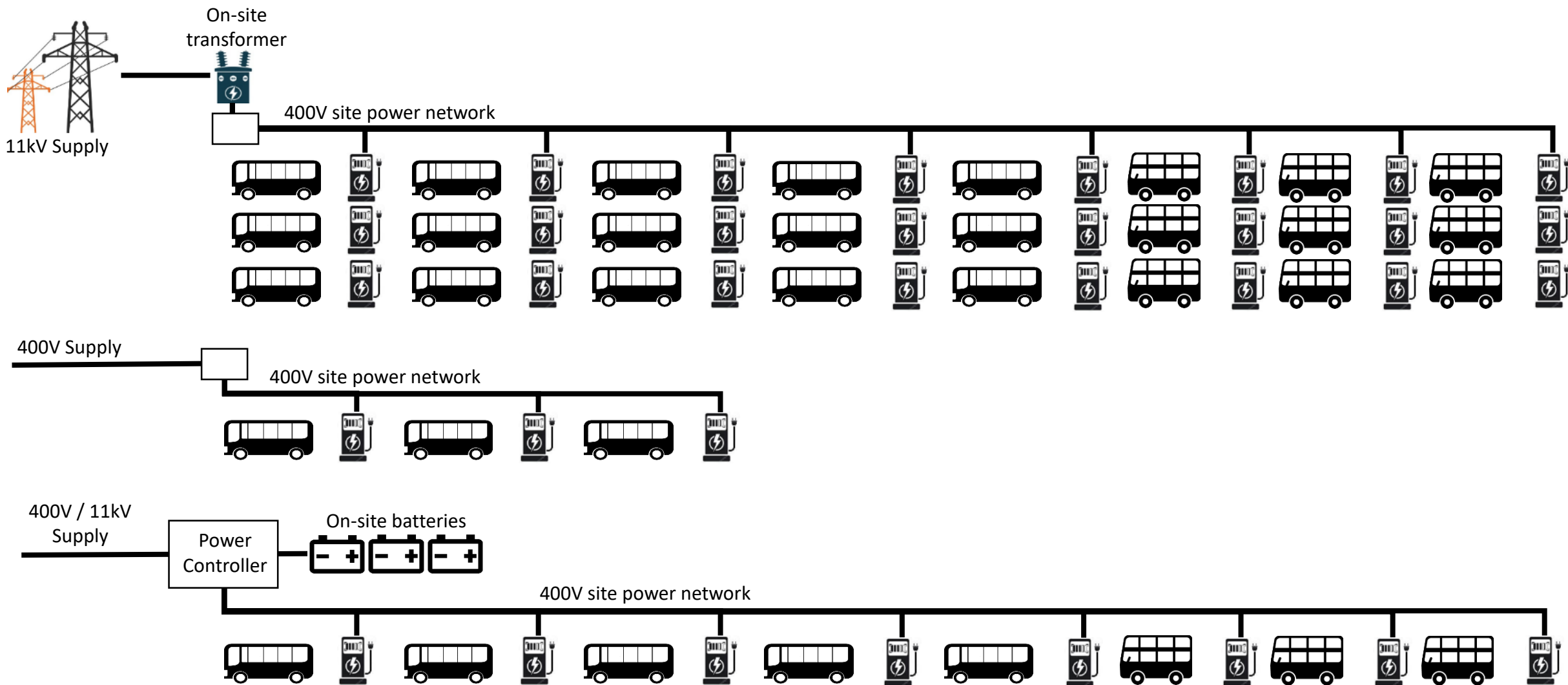
## CMS Managed Charging



*The same total energy is supplied in both cases*



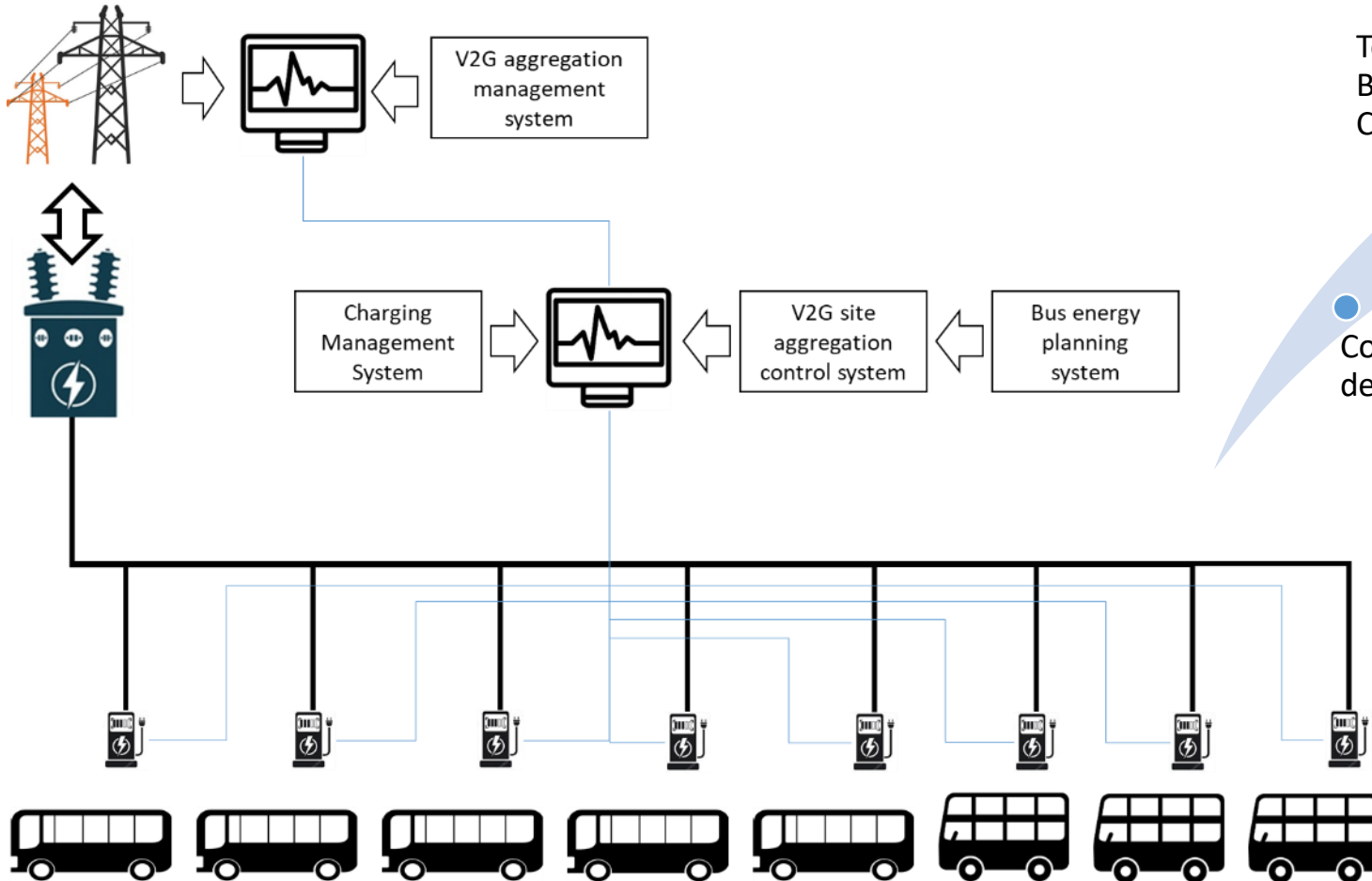
# Power Supply Configurations



# UK R&D: Vehicle-to-Grid



Innovate UK



Test installation at  
BYD's Iver Service  
Centre

Full scale operation at  
Northumberland Park

Controls  
development

Three year project, £2.41m Budget

Advisory Group





# The Challenge of Air Quality





# The Challenge of Global Warming



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Greenhouse gas emissions must be cut almost in half by 2030 to avert global environmental catastrophe, including the total loss of every coral reef, the disappearance of Arctic ice and the destruction of island communities, a landmark UN report has concluded.  
Drawing on more than 6,000 scientific studies and compiled over two years, the Intergovernmental Panel on Climate Change (IPCC) said that the world is facing "warming, sea-level rise and extreme weather events that will be increasingly frequent and intense."

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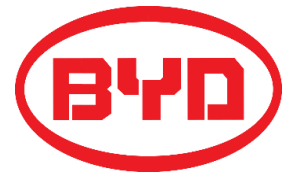
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# Thank You

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