

Challenges on charging infrastructure support

ELECTRIC BUS PROJECT AT WATERLOO BUS GARAGE, LONDON

10th November 2016

UK eBus Summit

Leonard Chew – BYD
Adrian Llewellyn – SSE



Contents

1. About Go-Ahead/BYD/SSE
2. Project overview
3. Challenges/solutions

About Us

Go-Ahead London



- Circa 25% London bus market
- 190 routes
- 2,300 buses
- 18 garages
- Introduced first hybrid buses in London
- Introduced first electric buses in London

About Us

BYD COMPANY LTD



- **Leading-edge** provider of **Green Energy** Technologies
- **World's largest** manufacturer of rechargeable batteries and **new-energy vehicles**
- More than **20 years** battery manufacturing experience
- Over **10,000** eBuses manufactured



BYD Pure Electric Bus and Coach Family

In the near future, BYD's roadmap to introduce a full spectrum of electrified **mini, midi, double-decker** and **articulated buses** and **BRT** solutions.

8.6-metre



10.8-metre



10.2-metre double-decker



12-metre coach



12-metre



18-metre articulated

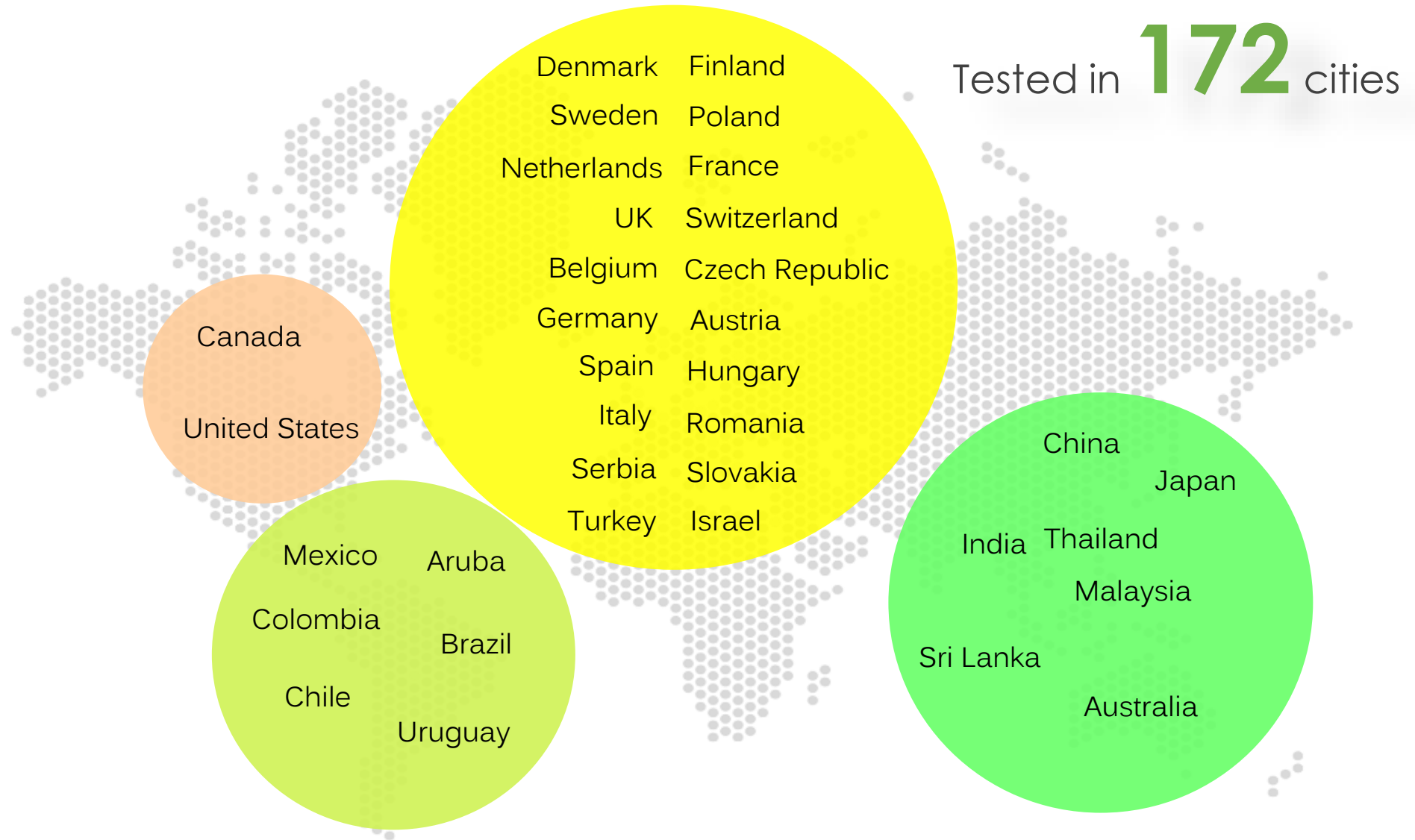


12-metre apron bus





BYD electric bus global footprint





BYD key projects in Europe



Schiermonnikoog, NL
6 units (Apr 2013)



Amsterdam Airport Schiphol, NL
35 units (Nov 2015)



Eskilstuna & Ängelholm, SE
2 & 5 units (Jan 2016)



London, UK
5 units (May 2016)



London, UK
51 units (Aug 2016)



Nottingham, UK
13 units (Oct 2016)

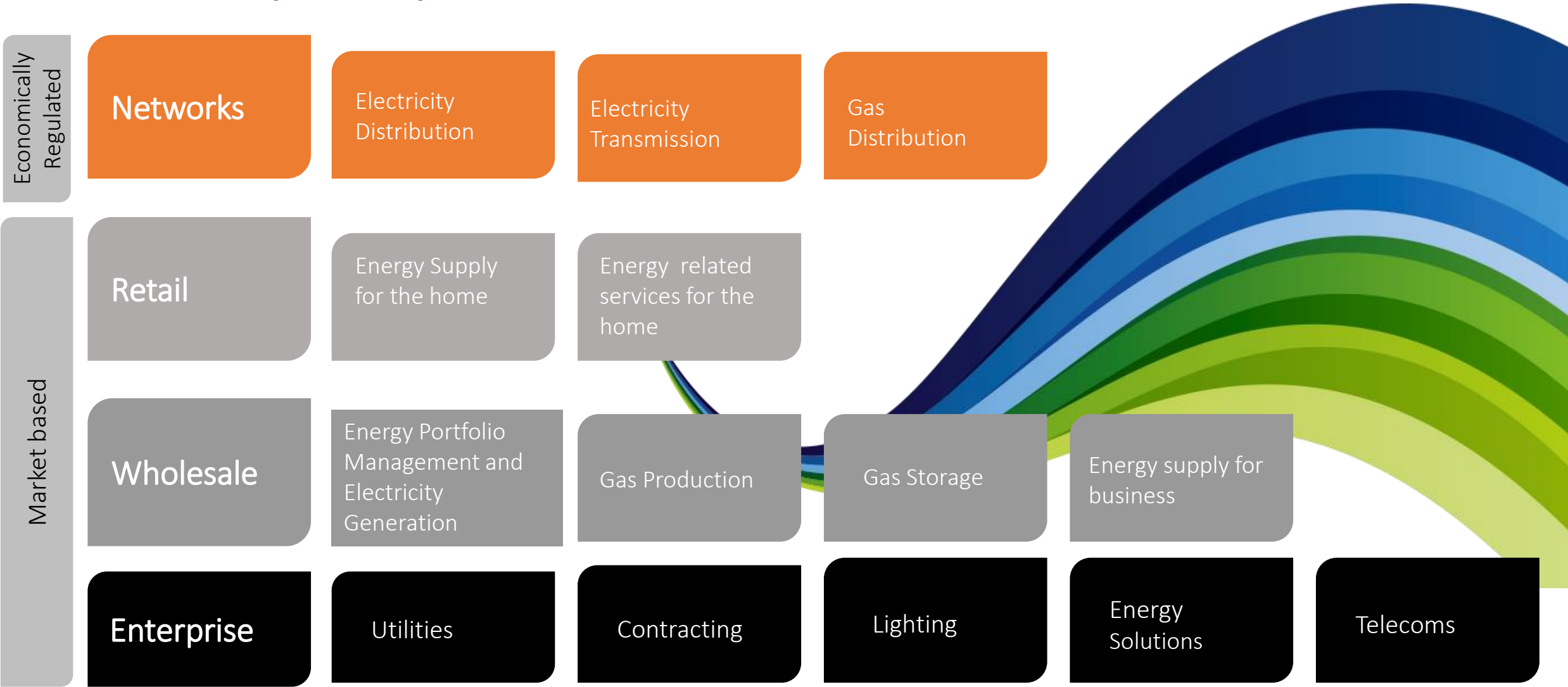
SSE

- 30th largest company in the FTSE 100*
- £14.95bn market capitalisation*
- Around 20,000 employees
- UK's broadest-based energy company
 - Electricity generation, transmission, distribution, supply and services
 - Gas production, storage, distribution, supply and services
- Ireland's fastest-growing energy company
 - Electricity generation
 - Electricity and gas supply
 - Street lighting maintenance
- Delivered a real dividend increase every year since 1999

*As at 22 July 2014



SSE Enterprise part of SSE PLC

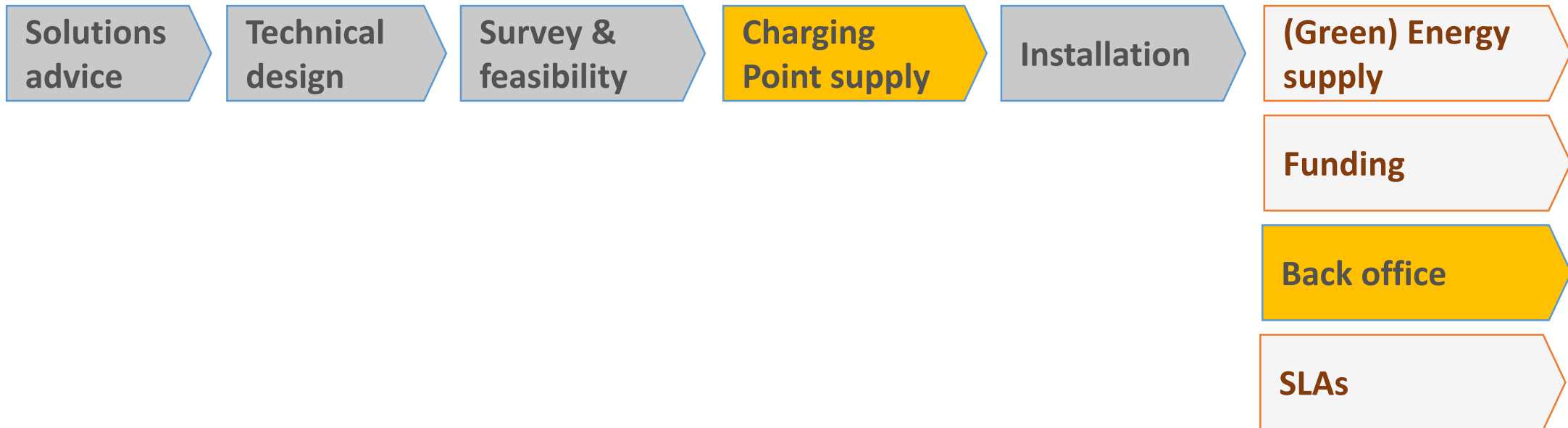


SSE Enterprise delivers essential services that improve



What's Next?

SSE's offer: end-to-end solutions



SSE is working towards the development of end-to-end solutions, adding value to their offer to customers (benefiting from spreading high upfront costs, equipment updates and business tax relief for leasing)

Legend:

To be offered in the future

Currently offered by SSE Enterprise

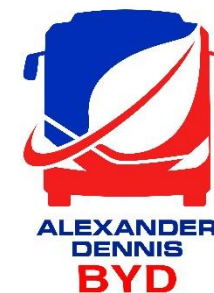
Partnership

The Project

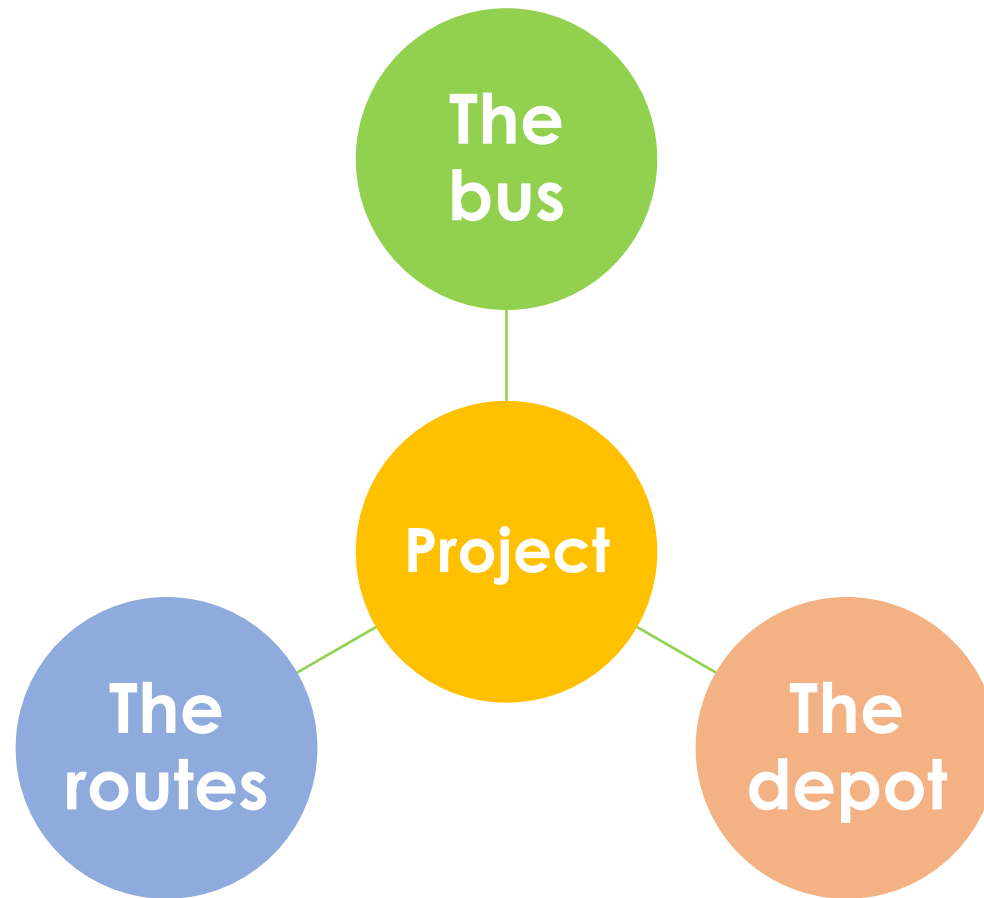
Waterloo Bus Garage, London



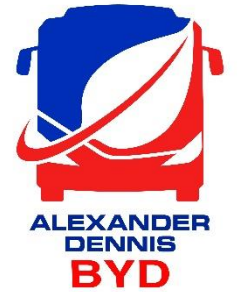
Stakeholders



Project 'ingredients'



The bus



0
emissions

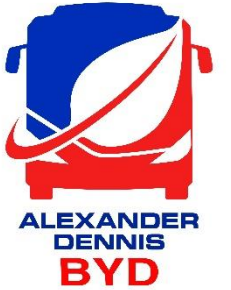
Reliable
battery

LOW
operating
cost

Single-
charge
operation

The bus

- BYD battery, powertrain and chassis + ADL body
- >250 km range, 4h charging time
- 90 passengers (21 seats)



The routes



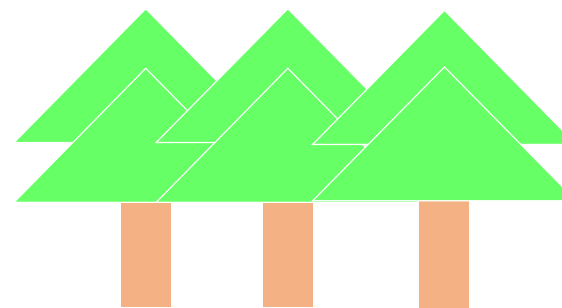
- Running through Ultra-Low Emissions Zone (ULEZ)
- 4.3 / 5.6 km per trip
- 0600 to 0030 overall operation
- High peak-time operation
- 7 million passengers per year
- 1 million km per year

The routes

CO₂ Reduction



=



Trees planted
5,069
yearly

*Well-to-wheel emission savings based on LowCVP and DEFRA grid electricity factors, mileage data from Transport for London, vehicle data based on LEB test cycle in the UK

The depot



The charger



Specifications

Type	AC, Mennekes, Type 2, three-phase
Voltage	400 V
Max power	40 kW x 2
Max current	126 A
Cable length	3 m

Challenges & solutions

Running a large-scale electric bus depot



Challenges

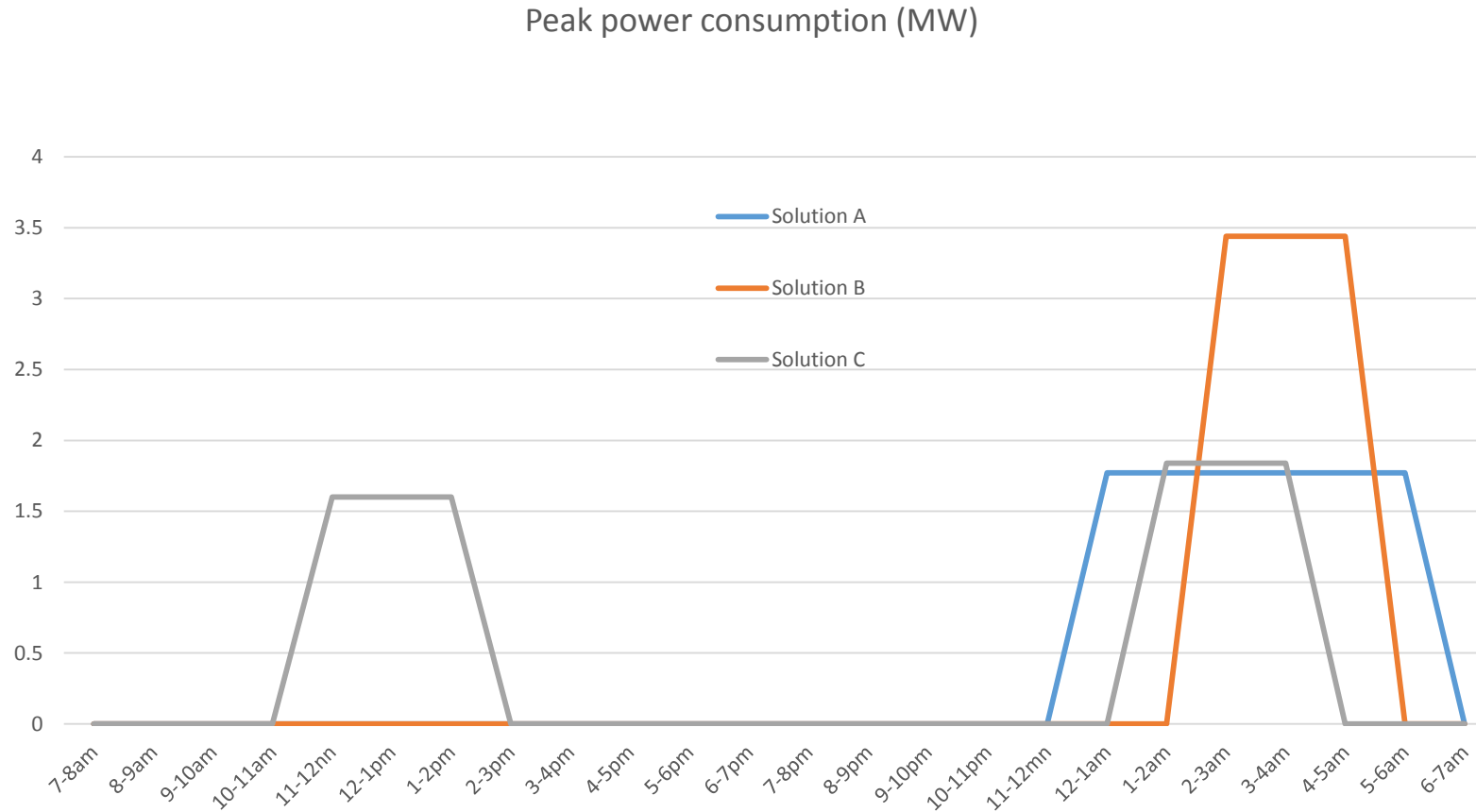
- Overall: Large fleet of electric buses charging
- **Space** – no room for expansion, movement of buses not possible when full, compact chargers needed
- **Power** – available capacity, connection shared with residential buildings
- **Time** – project delivery, work needed on infrastructure

Space

(or the lack of)



Power – How much is enough?



40
kW

80
kW

Day
+
night

Power – When to charge?



Image source: Transport for London

Solution: Overnight charging

- Single overnight charge
- 40kW
- Off-peak hours
- No additional vehicles/
dwell time required
- 43 chargers for 46 buses
(5 buses run out from another
garage)



Charging – a typical day's operation

~0030 Last bus returns

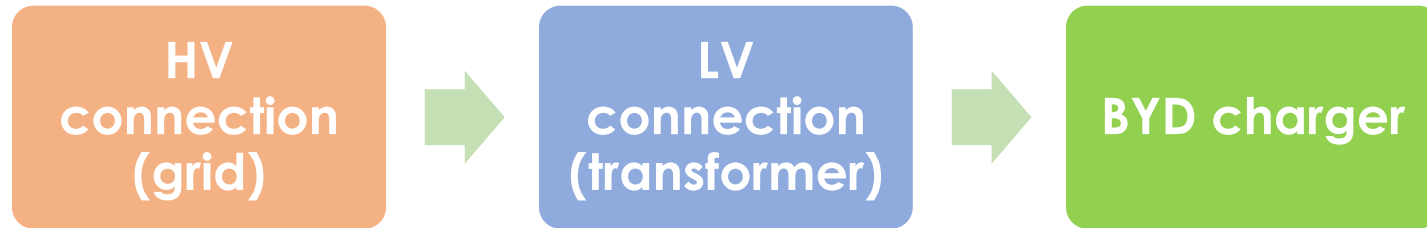
0000-0700 Charging window

~0600 First bus departs

At 40 kW, typically 2-5 hours required



The infrastructure



- Survey of existing power supply
- Securing supply
- Upgrade (transformers installed)
- Connection
- Input on expected loads



Summary: The BYD-ADL/SSE solution for Go-Ahead

- Infrastructure may be the greatest barrier but there are solutions
- Operational flexibility is key, understanding vehicle capability
- AC charging – efficient, simple and cost-effective
- Established case for overnight charging as one of the viable solutions for electrified city transportation

Thank you!

