

Towards a Delivery plan for the De-Carbonisation of First Bus

Garry Birmingham

Programme Director Decarbonisation Delivery

First Bus & Zero emissions



First Bus

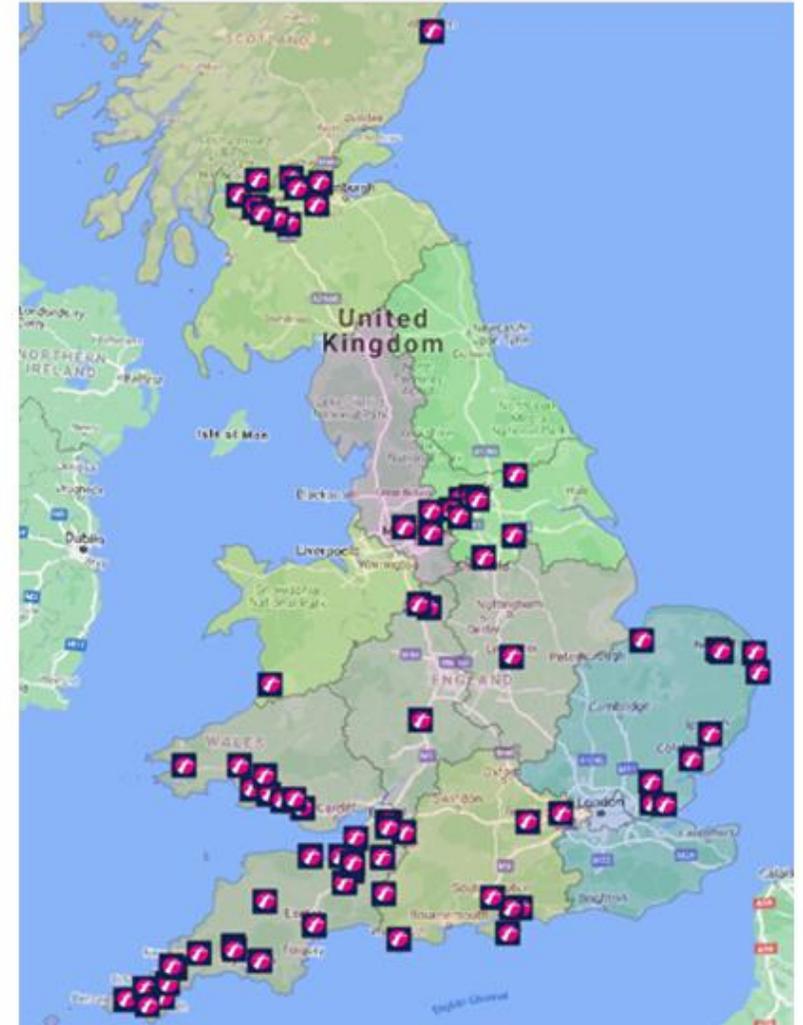
- One of the largest bus operators in the UK, serving 40 of the UK's largest towns and cities
- Current fleet size of 5085
- 64 Operating Depots

Big picture

- 31st March 2020 - First Group announces we will operate a 100% zero-emission bus fleet by 2035, and with no new diesel buses purchased after December 2022

Starting point;

- Start of 2021, 65 Zero emission buses, purchased in piecemeal solutions
- Technology uncertainties every where we looked.



Solving the delivery Rubik's cube



Issues to be Considered:

- Energy choice – EV, Hydrogen or both?
- Energy choice - On site? Off site? On road? AC/DC ccs plug? Pantograph?
- Range, Route Mileage, topography, depot ergonomics, complexity by site, run in run out practices
- Vehicles, type, size, weight, which Manufacturer, Range - Future Range?
- Consider BAU and make this clear to potential Civil Engineering Partners – Unless you are moving out while they work?
- Employee investment and training
- Smart software considerations on and of vehicle

The “Zero” story so far



Piecemeal Legacy

- York – 33 electric vehicles, mix of SDs and DDs, part funded through various rounds of the UK Green Bus Fund
- Leeds – 9 local bus services, 5 P&R and 7 electric DRT, part funded through Green Bus Fund and Transforming Cities.
- Aberdeen - 15 Hydrogen DD in partnership with Aberdeen City Council. Vehicles are refuelled off site at Aberdeen City Council Kitty Brewster depot.

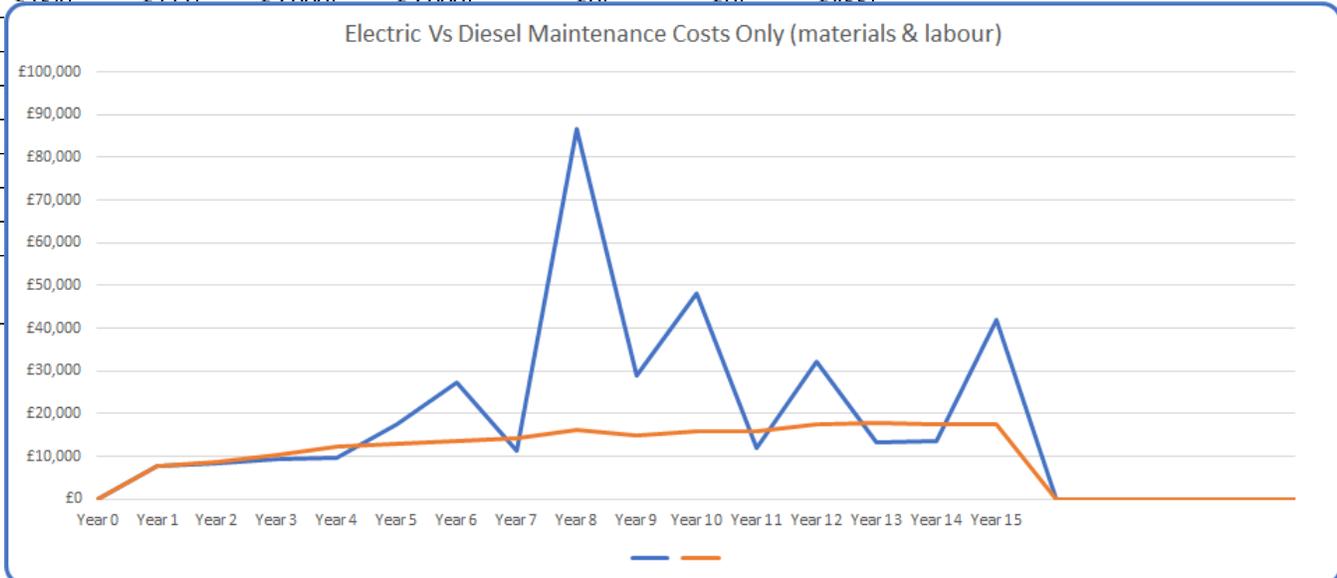
Next Steps

- Zebra – Zero Emission Buses Regional Authority (193 vehicles)
- Leicester – Fast track awarded 68 vehicles and infrastructure
- Outstanding bid for York, Norwich, Leeds and Solent
- SCOTZEB – Scottish Zero emission Bus bid submitted.

Bus TCO - EV v's Diesel (Materials and Labour)



Major Component	Bus CO1 DD	Bus Co1 SD	Bus CO2 DD	Bus CO2 DD	Bus CO3 DD	Bus CO3 DD	Bus CO4 SD
EV Drive Battery	£150,000	£150,000	£72,000	£90,000	£93,560	£93,560	£120,000
Air compressor	£0	£0	£0	£0	£0	£0	£14,810
Rear Axle Drive Motor	£0	£0	£0	£0	£0	£0	£5,500
Air Compressor	£37,912	17,085	£12,500	£5,956	£5,738	£5,738	£2,850
Coolant Pump	£0	£0	£1,350	£1,350	£1,100	£1,100	£1,469
EV Battery managenent	£3,500	£3,500	£0	£0	£4,391	£4,391	£1,339
DC-Dcconvertor 3KW	£3,787	£5,877	£5,000	£5,000	£0	£0	£662
EV BCM Assembly	£154	£111	£2,000	£2,000	£0	£0	£455
Electronic control							
Coolant Radiators							
Powertrain inverter							
DC/DC Inverters							
EV Drive Motor							
EV Drive axle							
Comproessor (x2)							
HH/LV Charging system							



- We know the cost of a diesel bus through its life.
- The Table shown is Major cost parts completed with OEM`s
- The TCO graph excludes battery replacement
- Spike due to accounting of predicted replacement of parts at a point in time.
- Engineering training will be needed, question labour savings due to the same `non oily bits`
- This generation of EV`s still immature for `what and when`
- EV reworking and reconditioning space will develop!
- Total TCO including fuel effect and infrastructure differs by site

Infrastructure and Technology Considerations - The hard bit!



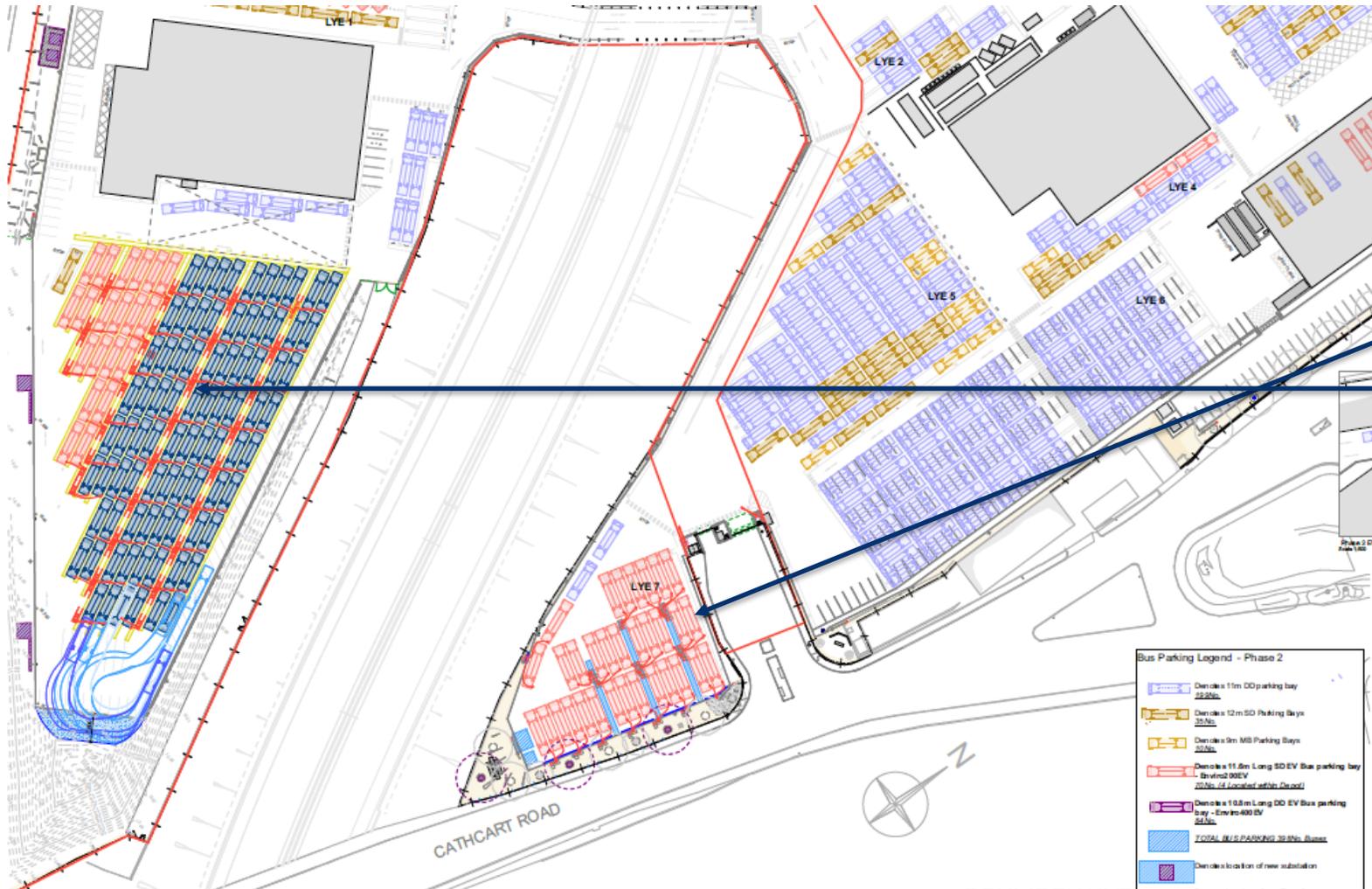
- EV or Hydrogen?
- Local Authority and regional plans?
- Charging : Fuelling **On site / off site** Fuelling /Opportunity charging
- Available space?
- Relocation of depot? **Timescales?**
- Hydrogen production- Expected Volumes?
- Amount of power to site MV, Capacity costs
- Smart charging
- AC/ DC Charging
- On site Modifications?
- **Costs, Capex? Opex? Grants?**
- Planning considerations
- Depot Modifications. Safety impact
- **Green Energy Supply**
- Cost of energy?
- Grid Connection / Availability
- **DNO Timelines**
- Hardware **Timelines- Warranty`s**
- Supplier (s) choice – Award?
- Turnkey considerations / **Partnerships**
- **Equipment Lifespans**
- Routine Maintaining of hardware, regulatory inspections ect
- On site Civil Engineering
- Other Innovation? Solar, Storage?
- Business as Usual operation
- Run in / Run out effects
- Labour increase / decrease effect on the above?
- Effect on whole Vehicle **Cascade** impact for depot 2 or 20?

Pathfinder Caledonia



- Caledonia is the largest Bus Garage in the UK and has a maximum site capacity of 430 ICE vehicles with a 320 current fleet
- The site spans both sides of the M74 motorway, situated next to the rail line and covers 16 Acres, We chose EV Technology solution with onsite overnight charging using our Heliox dual headed 150 DC Chargers
- Huge credit to Transport Scotland ambitions to drive Zero emissions and funding for SULEB 1 and SULEB 2
- SULEB 1 part funded 22 single deck order and SULEB 2 part funded 126 mix DD and SD plus 75% for associated infrastructure
- All civil engineering on site for Phase One was completed by September 2021 11 Dual headed chargers commissioned prior to Bus Deliveries in September and October in advance of COP26
- Phase 2 vehicles deliveries started in December 21 and will continue in tranches through 2022 and early 2023. Phase 2 civil works are progressing on plan with completion end of February 22 for all civils and the remaining 69 chargers
- This includes a Temporary 3.5MVA supply of power provided on site prior to a 33kVA Substation being built and commissioned by the end of the year which will leave SPEN capacity elsewhere in their network
- We have been working hand in hand with SPEN the DNO thought out this Journey with a real partnership approach for both Phase 1 and 2 with Civil engineering colleagues from Power systems and SSE working safely and methodically to plan
- We are working in Partnership with Hitachi with regarding further innovations around battery and software solutions
- Driver training , Engineering training is ongoing, site run in / run out / cleaning plans are being finalised

Phase 1 and 2 locations



80 Heliox DC 150kwh duel headed chargers in total, this will be able to charge 160 vehicles in total.

11 Phase one Chargers

63 Phase 2 Chargers

We are also fitting Chargers in the Engineering function

Pathfinder Caledonia – Reality



Thank You.