

Leicester ZEBRA Bid

Economic Case

August 2021



Economic Case

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Overview

1. This sets out the Economic Case of the Leicester ZEBRA bid. This aims to identify and understand the full impacts of the bid to determine the value for money to the taxpayer. Impacts include the costs and benefits to the environment, society, businesses, and government.
2. The overall value for money of the bid is measured by the product of:
 - a. The Benefit Cost Ratio (BCR) and Cost Effectiveness Indicators (CEI)
 - b. Key financial metrics
 - c. Consideration of Risk and Uncertainty
 - d. Non-monetised impacts
3. The analysis uses the DfT Greener Buses tool for each of the three projects within the bid and the programme as a whole to determine a series of baseline BCRs and CEIs, using the financial and output data set out within the Financial and Commercial Cases.
4. The financial metrics use information contained within the Financial Case, set against recent other projects.
5. An evaluation of risk is determined through a series of sensitivity tests on these baseline results.
6. Also set out is some information relating to the non-monetised benefits which are not included within the Greener Buses tool.
7. Taking into account the assessment of these three aspects, it is considered that the bid represents **reasonable** value for money.

The Benefit Cost Ratio Analysis

8. The following approach was utilised when using the Greener Bus tool:
 - a. Inclusion of all capital costs, including estimated battery replacement costs for both the Arriva and Council projects.
 - b. Battery replacement costs are paid for in full by Arriva and the Council, they are not subject to grant aid. For the First Bus project, the batteries last the lifetime of the bus.
 - c. Uses standard toolkit inputs for energy environmental make up, i.e. costs and emissions associated with energy. However, it should be noted that each operator is purchasing certified renewable energy for each of these projects: First and Arriva with SSE Energy and Centrebus with Zenobe Energy. These are not secured for the life of the project, and so are included as sensitivity tests and as likely non-monetised benefits.

- d. The renewable energy from Zenobe and SSE is mainly from hydroelectric/wind sources with a carbon value of around 11kg per kwhr. Again, this is only used in the sensitivity tests due to the fact it is not secured for the full life of the buses.
 - e. Current local costs for purchasing renewable electricity using locally determined contracts are in place or are being negotiated. First and Centrebus are currently purchasing this at REDACTED as part of large purchasing contracts. First Bus is expecting to negotiate this cost down REDACTED. Arriva are purchasing at [REDACTED], but this is firmly expected to fall significantly once significant numbers are operated. An average of 10.5p kwh is assumed, but again, is not guaranteed for the lifetime of the project. This local rate is therefore used for each project within a sensitivity test only.
 - f. A standard 17-year bus life has been used for all projects. It is considered that battery life (taking into account in-life replacement where necessary), together with chassis/drive train construction and maintenance will allow full operation of these buses on their chosen services for this period. All projects have been designed to 'mirror' existing bus ownership models as far as possible.
 - g. Uses locally determined annual infrastructure costs from First and Council suppliers. [REDACTED], so theirs is calculated on the basis of the same maintenance rate per charger as the Council. Sensitivity tests are included which show the impact if these costs are changed to the 'standardised' toolkit approach of 5% of capex costs.
 - h. Mileages are based on current operating mileage for the current routes moving to electric. Sensitivity tests are included which show the impact if mileages are higher or lower than assumed.
 - i. Classification of Leicester as a 'Urban big' geographic definition – its population in relation to these routes is over 650,000 and therefore this is appropriate.
 - j. Classification of the real non-traded Carbon value is set at the 'Central' value. Sensitivity tests show the impact of using the 'high' value.
 - k. Default basic BSOG rate, LCEB + AVL + real time for current diesel fleet.
9. A summary of the inputs used in the Greener Bus Tool is set out below:

Leicester ZEBRA Programme						
	Total	2021	2022	2023	2032	
Electric Buses in service	96	0	30	66	0	
Bus/Battery Cost	£ 41,514,000	£ -	£ 11,100,000	£ 26,334,000	£ 4,080,000	
Bus Grant	£ 14,842,500	£ -	£ 4,522,500	£ 10,320,000	£ -	
Infrastructure Cost	£ 5,539,129	£ 1,819,308	£ 2,499,821	£ 1,220,000	£ -	
Infrastructure Grant	£ 4,154,347	£ 1,364,481	£ 1,874,866	£ 915,000	£ -	
Total Grant	£ 18,996,847	£ -	£ 6,397,366	£ 11,235,000	£ -	
Total Operator	£ 28,056,282	£ 1,819,308	£ 7,202,455	£ 16,319,000	£ 4,080,000	
Total Cost	£ 47,053,129	£ 1,819,308	£ 13,599,821	£ 27,554,000	£ 4,080,000	

Green Bus Toolkit - input factors used				
	FirstBus	Arriva	Council	Programme
Distance Kms pa per bus			83,522	66,702
Life of buses			17	17
Nos Buses			6	96
Infrastructure maintenance costs			£ 13,579	£ 159,470
Cost electricity p/kwh			toolkit rate	toolkit rate
Carbon electricity kg/kwh			toolkit rate	toolkit rate
BSOG			£ 0.220	£ 0.220
Carbon trading value			central	central
Geography			Urban Big	Urban Big

10. The table below shows the minimum warranty specification for each project:

Warranties			
	Firstbus	Arriva	Council
	Length (years)	Length (years)	Length (years)
Vehicle			2
Battery			8
Powertrain			5
Structural			12

11. REDACTED

12. REDACTED

13. The table REDACTED

14. REDACTED

15. The Council diesel equivalent prices are based on a mid-range of prices for new Euro 6 buses which would meet current council contract specification, with a similar capacity as the proposed electric buses (Scania and ADL prices with a minimum of 35 seats).
16. Electric bus prices are based on current quoted costs and recent tenders with given suppliers, with documented quotes for the upgrades required to meet ZEBRA enhanced accessibility standards.
17. These may vary following full tendering and supplier evaluation and negotiations. Each partner will take full financial responsibility for all costs above these prices. Any final prices below those shown above will lead to the equivalent grant being returned to the grant administrator.
18. It should be noted that the proposed Council buses will be employed on the Outer Orbital all-day service and two other inter-worked contracted services. These have an average daily run of 267 kilometres and as such the mileage statistics used in the Greener Bus tool are higher than the other projects. However, there is very little 'dead' mileage, as the depot is on the routes. Trials have shown that this range can be completed by the Yutong buses currently in operation in Leicester. The route is flat and there is good regenerative braking energy recouped. Even with upto 80% degradation by year 8, there is confidence that there will be sufficient energy to complete the full service.
19. Set out below are the key Summary and Benefit Cost Ratio output tables for each project and the programme as a whole, calculated using the above factors in the toolkit.

First Bus Project

First Bus Base Case Summary output

Table Redacted

First Bus Base Case BCR Table

Table Redacted

Arriva Project

Arriva – Base Case Summary output

REDACTED

Arriva – Base Case BCR output table

REDACTED

Council Project

Council – Base Case Summary Table

File Name		Greener Buses Model - ZEBRA Phase 2 Council 7 new.xlsm			
Sheet Name		O- Summary			
Description and Purpose of Sheet		This sheet summarises the costs and benefits calculated on previous sheets			
Summary					
Active Scenario	Sc. 1 - ZEBRA business case	Constant	Unit		
Appraisal Period Flag			flag		
Benefits					
Carbon					
Incremental Impact of Carbon	Note - negative sign added to convert a saving to a positive number		£, 2021, PV		1,703,045
Incremental Carbon Emissions	Note - negative sign is a carbon saving		kg CO2e	-	7,118,552
Incremental Carbon Emissions	Note - negative sign is a carbon saving		tonnes CO2e	-	7,119
Emissions					
Incremental Impact of Nox	Note - negative sign added to convert a saving to a positive number		£, 2021, PV		42,604
Incremental Nox Emissions	Note - negative sign is a NOx saving		kg	-	3,408
Incremental Nox Emissions	Note - negative sign is a NOx saving		tonnes	-	3
Incremental Impact of PM2.5	Note - negative sign added to convert a saving to a positive number		£, 2021, PV		20,315
Incremental PM2.5 Emissions	Note - negative sign is a PM2.5 saving		kg	-	85
Incremental PM2.5 Emissions	Note - negative sign is a PM2.5 saving		tonnes	-	0
Electricity Consumption					
Incremental Electricity Consumption			kWh		8,519,244
Hydrogen Consumption					
Incremental Hydrogen Consumption			kg		-
Costs					
Vehicle CapEx					
Grant		Public	£, 2021 w/ OB, PV, MP		861,038
Costs to the Public Sector		Public	£, 2021 w/ OB, PV, MP		1,760,353
Costs to the Private Sector		Private	£, 2021 w/ OB, PV, MP		-
DM fleet replacement costs					
Do Minimum Cost of Fleet Replacement (saved)		Private	£, 2021, w/OB, PV, MP		923,055
Infrastructure CapEx					
Grant		Public	£, 2021 w/ OB, PV, MP		267,046
Costs to the Public Sector		Public	£, 2021 w/ OB, PV, MP		89,015
Costs to the Private Sector		Private	£, 2021 w/ OB, PV, MP		-
Vehicle Maintenance Costs					
Incremental maintenance cost		Private	£, 2021 w/ OB, PV, MP	-	673,818
Infrastructure Maintenance Costs					
Incremental maintenance cost		0%	£, 2021, w/OB, PV, MP		225,233
Operating Costs					
Incremental Operating Costs	Resource Cost	Private	£, 2021 w/ OB, PV	-	202,017
Incremental Operating Costs	Duty	Private	£, 2021 w/ OB, PV	-	1,722,261
Incremental Operating Costs	VAT	Private	£, 2021 w/ OB, PV		-
<i>Negative costs suggest a saving under the DS option</i>					
BSOG					
Incremental BSOG	Impact on Government		£, 2021, PV		39,730
Indirect Tax					
Incremental indirect tax revenues	Impact on Government		£, 2021, w/OB, PV, MP		-
Incremental Fuel/Electricity/Hydrogen Duty	Impact on Government		£, 2021 w/ OB, PV	-	1,722,261
Incremental Fuel/Electricity/Hydrogen VAT	Impact on Government		£, 2021 w/ OB, PV		-
END					

Council – Base Case BCR Table

BCR				
Active Scenario			Sc. 1 - ZEBRA buisness case	Constant
Appraisal Period Flag				
BCR Calculation				
Impacts				£, 2021, PV
Carbon Impact				1,703,045
Nox Impact				42,604
PM Impact				20,315
Indirect Tax Impact (Vehicles)				-
Indirect Tax Impact (Fuel/Electric Duty)				- 1,722,261
Indirect Tax Impact (Fuel/Electric VAT)				-
BSOG		Private		39,730
Vehicle Maintenance Cost		Private		673,818
Infra Maintenance Cost		Private		-
Operating Cost		Private	Resource	202,017
Operating Cost		Private	Duty	1,722,261
Operating Cost		Private	VAT	-
Vehicle CapEx		Private		-
DM Fleet Replacement CapEx		Private		923,055
Infra CapEx		Private		-
Costs (Broad Transport Budget)				
Vehicle CapEx		Grant		861,038
Vehicle CapEx		Public		1,760,353
DM Fleet Replacement CapEx		Public		-
Infra CapEx		Grant		267,046
Infra CapEx		Public		89,015
Vehicle Maintenance Cost		Public		-
Infra Maintenance Cost		Public		-
Operating Cost		Public	Resource	-
Operating Cost		Public	Duty	-
Operating Cost		Public	VAT	-
BSOG		Public		39,730
Present Value of Benefits	PVB			3,604,586
Present Value of Costs	PVC			3,017,183
Net Present Value	NPV			587,403
Benefit Cost Ratio	BCR			1.19
Cost Effectiveness Indicator	CEI			156.7
END				

20. These have been consolidated into a Programme level Greener Bus Tool as below:

Programme

Programme : Base Case Summary Table

File Name		Greener Buses Model - ZEBRA Phase 2 All Projects 7 new.xlsm			
Sheet Name		O- Summary			
Description and Purpose of Sheet		This sheet summarises the costs and benefits calculated on previous sheets			
Summary					
Active Scenario	Sc. 1 - ZEBRA business case	Constant	Unit		
Appraisal Period Flag			flag		
Benefits					
Carbon					
Incremental Impact of Carbon	Note - negative sign added to convert a saving to a positive number		£, 2022, PV		23,102,648
Incremental Carbon Emissions	Note - negative sign is a carbon saving		kg CO2e	-	90,513,389
Incremental Carbon Emissions	Note - negative sign is a carbon saving		tonnes CO2e	-	90,513
Emissions					
Incremental Impact of Nox	Note - negative sign added to convert a saving to a positive number		£, 2022, PV		580,732
Incremental Nox Emissions	Note - negative sign is a NOx saving		kg	-	43,543
Incremental Nox Emissions	Note - negative sign is a NOx saving		tonnes	-	44
Incremental Impact of PM2.5	Note - negative sign added to convert a saving to a positive number		£, 2022, PV		276,916
Incremental PM2.5 Emissions	Note - negative sign is a PM2.5 saving		kg	-	1,089
Incremental PM2.5 Emissions	Note - negative sign is a PM2.5 saving		tonnes	-	1
Electricity Consumption					
Incremental Electricity Consumption			kWh		108,858,344
Hydrogen Consumption					
Incremental Hydrogen Consumption			kg		-
Costs					
Vehicle CapEx					
Grant		Public	£, 2022 w/ OB, PV, MP		15,219,849
Costs to the Public Sector		Public	£, 2022 w/ OB, PV, MP		1,857,546
Costs to the Private Sector		Private	£, 2022 w/ OB, PV, MP		24,334,779
DM fleet replacement costs					
Do Minimum Cost of Fleet Replacement (saved)		Private	£, 2022, w/OB, PV, MP		18,080,926
Infrastructure CapEx					
Grant		Public	£, 2022 w/ OB, PV, MP		5,212,435
Costs to the Public Sector		Public	£, 2022 w/ OB, PV, MP		93,930
Costs to the Private Sector		Private	£, 2022 w/ OB, PV, MP		1,643,548
Vehicle Maintenance Costs					
Incremental maintenance cost		Private	£, 2022 w/ OB, PV, MP	-	9,184,752
Infrastructure Maintenance Costs					
Incremental maintenance cost		Private	£, 2022, w/OB, PV, MP		2,720,428
Operating Costs					
Incremental Operating Costs	Resource Cost	Private	£, 2022 w/ OB, PV	-	2,721,001
Incremental Operating Costs	Duty	Private	£, 2022 w/ OB, PV	-	23,411,703
Incremental Operating Costs	VAT	Private	£, 2022 w/ OB, PV		-
<i>Negative costs suggest a saving under the DS option</i>					
BSOG					
Incremental BSOG	Impact on Government		£, 2022, PV		545,499
Indirect Tax					
Incremental indirect tax revenues	Impact on Government		£, 2022, w/OB, PV, MP		-
Incremental Fuel/Electricity/Hydrogen Duty	Impact on Government		£, 2022 w/ OB, PV	-	23,411,703
Incremental Fuel/Electricity/Hydrogen VAT	Impact on Government		£, 2022 w/ OB, PV		-
END					

Programme : Base Case BCR Table

Description and Purpose of Sheet		This sheet calculates the BCR, CEI and shows a das	
BCR			
Active Scenario		Sc. 1 - ZEBRA buisness case	Constant
Appraisal Period Flag			
BCR Calculation			
Impacts			£, 2022, PV
Carbon Impact			23,102,648
Nox Impact			580,732
PM Impact			276,916
Indirect Tax Impact (Vehicles)			-
Indirect Tax Impact (Fuel/Electric Duty)			- 23,411,703
Indirect Tax Impact (Fuel/Electric VAT)			-
BSOG	Private		545,499
Vehicle Maintenance Cost	Private		9,184,752
Infra Maintenance Cost	Private		- 2,720,428
Operating Cost	Private	Resource	2,721,001
Operating Cost	Private	Duty	23,411,703
Operating Cost	Private	VAT	-
Vehicle CapEx	Private		- 24,334,779
DM Fleet Replacement CapEx	Private		18,080,926
Infra CapEx	Private		- 1,643,548
Costs (Broad Transport Budget)			
Vehicle CapEx	Grant		15,219,849
Vehicle CapEx	Public		1,857,546
DM Fleet Replacement CapEx	Public		-
Infra CapEx	Grant		5,212,435
Infra CapEx	Public		93,930
Vehicle Maintenance Cost	Public		-
Infra Maintenance Cost	Public		-
Operating Cost	Public	Resource	-
Operating Cost	Public	Duty	-
Operating Cost	Public	VAT	-
BSOG	Public		545,499
Present Value of Benefits	PVB		25,793,718
Present Value of Costs	PVC		22,929,259
Net Present Value	NPV		2,864,459
Benefit Cost Ratio	BCR		1.12
Cost Effectiveness Indicator	CEI		223.6
END			

21. The tables above show the following:

- There is a base case positive BCR for the programme as a whole, shown above at 1.12. This is categorised as 'low' value for money prior to consideration of non-monetized benefits and risks/uncertainties.
- There is a BCR of over 1 for two of the three projects – First Bus and Council projects.

Key Financial Metrics

22. The following key financial performance metrics have been calculated to assist in demonstrating value for money at both a project and programme level.

Key Financial performance metrics					
Project:	FirstBus	Arriva	Council	Council	Programme
	Bid	Bid	Bid	Previous	
Bus Costs					
Electric bus			£ 359,000	£ 355,000	£ 389,938
Battery replacement			£ 130,000	£ 130,000	£ 42,500
Diesel replace			£ 160,000	£ 155,000	£ 183,792
Upgrade cost			£ 329,000	£ 330,000	£ 248,646
Upgrade cost - grant			£ 149,250	£ 150,000	£ 154,609
Capacity/bus			36	36	43
Mileage over 17 years/bus			1,419,874	1,419,874	£ 1,133,941
Upgrade cost/seat			£ 9,139	£ 9,167	£ 5,771
Upgrade cost/mile over life			£ 0.23	£ 0.23	£ 0.22
Carbon saving (tonnes total)			7,950	8,788	91,349
Carbon saving/bus			1,325	799	£ 952
Upgrade cost/carbon saving			£ 248.30	£ 413.08	£ 261.31
Grant cost/carbon saving			£ 112.64	£ 187.77	£ 162.48
Infrastructure Costs					
Costs - ZEBRA			£ 300,664	0	£ 5,539,129
Costs/ZEBRA bus			£ 50,111	0	57699
Grant costs/ZEBRA bus			£ 37,583	0	£ 43,274
Electric buses per depot 2024			10	11	£ 43,979
Maximum nos buses per depot			20	20	
Remaining number of chargers required			5	£ 5	100
Projected costs for new chargers			£ 37,000	£ 37,000	180
Costs - previous projects			£ 251,000	£ 607,854	£ 251,000
Costs - remaining chargers			£ 185,000	£ 185,000	£ 2,145,000
Costs - remaining power upgrade			£ -	£ -	£ 300,000
Costs - depot total inc ZEBRA			£ 736,664	£ 792,854	£ 7,935,129
Costs - bus for complete depot			£ 36,833	£ 39,643	£ 44,084
Total Costs					
Upgrade Cost per mile over life			£ 0.27	£ 0.23	£ 0.27
Grant per mile over life			£ 0.14	£ 0.11	£ 0.20
Upgrade cost/carbon saving (t)			£ 286.12	£ 413.08	£ 321.94
Grant cost/carbon saving (t)			£ 141.01	£ 187.77	£ 207.96

23. These are shown on the basis of both total costs and taxpayer grant. It is important to note that these focus solely on the costs and benefits of upgrading from diesel to electric, they ignore the additional operator investment costs associated with the 'diesel equivalent cost' of the electric bus purchase.
24. For the proposed Council project, a comparison with a very recent similar project is also shown - where buses with a more basic bus specification were employed. This shows a high cost per carbon tonne saved, largely due to significantly lower operating mileage – the services not running in the evenings or on Sundays. Infrastructure costs per bus were in line with the projects in the ZEBRA proposed programme.
25. Infrastructure costs per bus have been shown on the basis of the ZEBRA scheme alone, but also on the basis of taking into account previous depot work and potential additional future buses. An estimate of future costs required by depot is set out, to give a likely overall cost per bus once the depot is complete.
26. The project differences reflect their different scale and route type:
- Arriva's costs are high compared to First's since they include significant battery replacement costs – the lifetime upgrade costs for double deckers is significantly higher.
 - Council's costs are low due the project scale, power required, and high mileage of the routes involved.

Consideration of Risk and Uncertainty

27. Sensitivity tests have been done on the following parameters for each project:

- Battery replacement costs
- Changes to operating mileage
- Change to BSOG rates
- Change to Carbon rating
- Renewable electricity type and costs.
- Change to default maintenance costs

28. These are also shown at both individual project and consolidated programme level.

Battery Replacement Costs

29. The analysis includes costs for replacement batteries for the Arriva and Council projects only, predicted to be in year 2032.

30. The sensitivity analysis sets out the impact of:

- Battery replacement costs increasing by 10%
- Battery replacement costs decreasing by 10%
- Battery replacement costs being removed.

31. It should be noted that battery replacement costs only affects 29% of the buses in the programme. The majority (71%) of buses are on the First Bus project, where the battery

system is expected to last for the lifetime of the bus, with no replacement necessary.

32. The sensitivity showing battery costs being removed has been included because it is currently not known whether:

- a) The initial batteries might last well beyond 2032. All projects use smart management software and full maintenance and driver training programmes. Experience in Nottingham after 12 years of electric bus operation has shown that the existing batteries are still operationally adequate.
- b) Even with battery mileage degradation over time, it might be still possible to run the majority of the timetable on electric buses with their original batteries for the full 17 years.
- c) The price of batteries might have fallen significantly over this period and/or their efficiency vastly improved – as has happened over the past decade.
- d) The initial batteries will have significant value for other non-bus operations, such as battery storage.

33. The results of the battery replacement sensitivities are set out in the table below:

<u>Benefit Cost Ratios</u>					
with replacement battery costs					
		Firstbus	Arriva	Council	Programme
Present Value of Benefits	PVB			£ 3,604,586	£ 25,793,718
Present Value of Costs	PVC			£ 3,017,183	£ 22,929,259
Net Present Value	NPV			£ 587,403	£ 2,864,459
Benefit Cost Ratio	BCR			1.19	1.12
Cost Effectiveness Indicator	CEI			156.72	223.59
<u>Benefit Cost Ratios</u>					
with replacement battery costs 10% higher					
				Council	Programme
Present Value of Benefits	PVB			£ 3,604,586	£ 25,548,051
Present Value of Costs	PVC			£ 3,072,212	£ 22,987,326
Net Present Value	NPV			£ 532,374	£ 2,560,725
Benefit Cost Ratio	BCR			1.17	1.11
Cost Effectiveness Indicator	CEI			164.45	226.95
<u>Benefit Cost Ratios</u>					
with replacement battery costs 10% lower					
				Council	Programme
Present Value of Benefits	PVB			£ 3,604,586	£ 26,039,385
Present Value of Costs	PVC			£ 2,962,155	£ 22,871,193
Net Present Value	NPV			£ 642,431	£ 3,168,193
Benefit Cost Ratio	BCR			1.22	1.14
Cost Effectiveness Indicator	CEI			148.99	220.24

34. This shows that the programme has relatively low sensitivity to the cost of battery replacement.
35. It also should be noted that removing battery replacement costs entirely gives an overall BCR of 1.26 and makes the Arriva project have a BCR of 0.98 (not shown in table above).

Change to Operating Mileage

36. Below is a summary of the impact of changing the operating mileage by +/- 10%.

<u>Benefit Cost Ratios</u>					
mileage current					
		Firstbus	Arriva	Council	Programme
Present Value of Benefits	PVB			£ 3,604,586	£ 25,793,718
Present Value of Costs	PVC			£ 3,017,183	£ 22,929,259
Net Present Value	NPV			£ 587,403	£ 2,864,459
Benefit Cost Ratio	BCR			1.19	1.12
Cost Effectiveness Indicator	CEI			156.72	223.59
<u>Benefit Cost Ratios</u>					
mileage 10% +					
				Council	Programme
Present Value of Benefits	PVB			£ 3,872,739	£ 29,434,873
Present Value of Costs	PVC			£ 3,021,156	£ 22,983,809
Net Present Value	NPV			£ 851,583	£ 6,451,064
Benefit Cost Ratio	BCR			1.28	1.28
Cost Effectiveness Indicator	CEI			130.49	190.45
<u>Benefit Cost Ratios</u>					
mileage 10% -					
				Council	Programme
Present Value of Benefits	PVB			£ 3,336,433	£ 22,152,563
Present Value of Costs	PVC			£ 3,013,210	£ 22,874,709
Net Present Value	NPV			£ 323,223	-£ 722,146
Benefit Cost Ratio	BCR			1.11	0.97
Cost Effectiveness Indicator	CEI			188.79	264.10

37. The impact of mileage variation on the BCR is reasonably strong at around 14% for a 10% change. The current operating mileage for the First Bus and Arriva projects is such that there will still be sufficient daytime battery capacity to increase mileage by upto 10%.
38. Although the programme BCR falls just below 1 if mileage drops by 10%, it should be noted that this is highly unlikely to happen in Leicester. If demand fell on a given route such that a reduction in service level is required to maintain profit margins, then it is more likely that the route would drop in frequency and buses reallocated to another growing service or onto contract work. It is very unlikely that costs would be cut by reducing route length or the hours of operation of each bus.

Change to BSOG Rates

39. Below is a summary of the impact of changing BSOG back to £0.06/km

<u>Benefit Cost Ratios</u>					
BSOG = £0.22					
		Firstbus	Arriva	Council	Programme
Present Value of Benefits	PVB			£ 3,604,586	£ 25,793,718
Present Value of Costs	PVC			£ 3,017,183	£ 22,929,259
Net Present Value	NPV			£ 587,403	£ 2,864,459
Benefit Cost Ratio	BCR			1.19	1.12
Cost Effectiveness Indicator	CEI			156.72	223.59
<u>Benefit Cost Ratios</u>					
BSOG = £0.06					
				Council	Programme
Present Value of Benefits	PVB			£ 2,799,102	£ 14,734,434
Present Value of Costs	PVC			£ 2,211,699	£ 11,869,975
Net Present Value	NPV			£ 587,403	£ 2,864,459
Benefit Cost Ratio	BCR			1.27	1.24
Cost Effectiveness Indicator	CEI			156.72	223.59

40. REDACTED

Change to Carbon Value

41. Below is a summary of the impact of changing the Real non-traded Carbon value to low and high.

<u>Benefit Cost Ratios</u>					
Carbon - central					
		Firstbus	Arriva	Council	Programme
Present Value of Benefits	PVB			£ 3,604,586	£ 25,793,718
Present Value of Costs	PVC			£ 3,017,183	£ 22,929,259
Net Present Value	NPV			£ 587,403	£ 2,864,459
Benefit Cost Ratio	BCR			1.19	1.12
Cost Effectiveness Indicator	CEI			156.72	223.59
<u>Benefit Cost Ratios</u>					
Carbon - high					
				Council	Programme
Present Value of Benefits	PVB			£ 4,456,109	£ 37,345,042
Present Value of Costs	PVC			£ 3,017,183	£ 22,929,259
Net Present Value	NPV			£ 1,438,926	£ 14,415,783
Benefit Cost Ratio	BCR			1.48	1.63
Cost Effectiveness Indicator	CEI			156.72	223.59
<u>Benefit Cost Ratios</u>					
Carbon - low					
				Council	Programme
Present Value of Benefits	PVB			£ 2,753,063	£ 14,242,394
Present Value of Costs	PVC			£ 3,017,183	£ 22,929,259
Net Present Value	NPV			£ 264,120	-£ 8,686,865
Benefit Cost Ratio	BCR			0.91	0.62
Cost Effectiveness Indicator	CEI			156.72	223.59

42. This shows that the programme and indeed each project is very sensitive to the societal value placed on carbon. A lower value tips the programme and each project below 1. A higher value gives a BCR value over one for all three projects and a programme value of 1.63, up by 45% from the medium default level.

Energy Type Changes

43. This shows the impact of changing to the renewable energy and model rates using current local contracts in place.

<u>Benefit Cost Ratios</u>					
Non renewable					
		Firstbus	Arriva	Council	Programme
Present Value of Benefits	PVB			£ 3,604,586	£ 25,793,718
Present Value of Costs	PVC			£ 3,017,183	£ 22,929,259
Net Present Value	NPV			£ 587,403	£ 2,864,459
Benefit Cost Ratio	BCR			1.19	1.12
Cost Effectiveness Indicator	CEI			156.72	223.59
<u>Benefit Cost Ratios</u>					
Renewable energy and local costs					
		Firstbus	Arriva	Council	Programme
Present Value of Benefits	PVB			£ 4,122,759	£ 32,848,334
Present Value of Costs	PVC			£ 3,017,183	£ 22,929,259
Net Present Value	NPV			£ 1,105,576	£ 9,919,074
Benefit Cost Ratio	BCR			1.37	1.43
Cost Effectiveness Indicator	CEI			83.93	145.65

44. This shows the reasonable strong sensitivity to each project and programme to fuel type purchased. Using renewable energy and current local purchasing costs bring the BCR up by 27%.

45. It should be noted that the ability to determine reduced local rates should rise over time as the main operators move more of their fleet over to electric and they get stronger 'bulk buying' discount power.

Change to Infrastructure Maintenance Costs

46. This table shows the impact of defaulting to a 'standard' infrastructure maintenance cost set at 5% of capital expenditure cost. This is considered very unlikely given the position all projects are at with their suppliers in determined locally negotiated annual maintenance contracts.

Benefit Cost Ratios					
Local maintenance contracts - infrastructure					
		Firstbus	Arriva	Council	Programme
Present Value of Benefits	PVB			£ 3,604,586	£ 25,793,718
Present Value of Costs	PVC			£ 3,017,183	£ 22,929,259
Net Present Value	NPV			£ 587,403	£ 2,864,459
Benefit Cost Ratio	BCR			1.19	1.12
Cost Effectiveness Indicator	CEI			156.72	223.59
Benefit Cost Ratios					
Standardised maintenance costs - infrastru					
				Council	Programme
Present Value of Benefits	PVB			£ 3,604,586	£ 23,789,495
Present Value of Costs	PVC			£ 3,017,183	£ 22,929,259
Net Present Value	NPV			£ 587,403	£ 860,236
Benefit Cost Ratio	BCR			1.19	1.04
Cost Effectiveness Indicator	CEI			156.72	245.74

47. This shows a relatively low sensitivity to this factor, with the programme remaining above a BCR of 1 if current negotiated local service contracts are terminated or rise to 'standard' levels in the future.

Sensitivity Summary

48. A summary of these sensitivity tests is shown below.

Programme BCR Sensitivity				
	Before	After	Change	Sensitivity
Battery costs up	1.12	1.11	-1.2%	low
Battery cost down	1.12	1.14	1.2%	low
Mileage up	1.12	1.28	13.8%	medium
Mileage down	1.12	0.97	-13.9%	medium
BSOG down	1.12	1.24	10.3%	medium
Carbon High	1.12	1.63	44.8%	high
Carbon low	1.12	0.62	-44.8%	high
Renewable	1.12	1.43	27.4%	high
Maintenance costs	1.13	1.05	-7.1%	low

Other non-quantified risks.

49. The high-level non-quantified key risks identified by the partnership have recently been re-assessed in terms of severity and likelihood. The previous experience of each partner in this area, together with ongoing mitigation work and due diligence being undertaken

on various levels outlined in the Management Case concludes that all the high level main risks are now scored as low.

High Level Risk Analysis				
Aug-21				
Business objective	Risk	Score - Impact (4 highest)	Score - Likelihood (4 highest)	Score Combined (16 highest)
One or more projects not delivered to specification - bus. (Particularly where using new untested supplier)	Impact on ability to operate the service using electric buses, could impact on ongoing operational costs/individual project business case, together with Zebra funding aims and rules	3	1	3
One or more projects not delivered to specification - depots	Impact on ability to operate the service using electric buses, could impact on ongoing operational costs/individual project business case.	3	1	3
Complete the programme on time	Programme/projects not delivered within timescale, impacts on funding rules, reputation and future investment plans	2	1	2
Operator matched financing arrangements and own internal business case changes prior to ordering.	Impact on whole of Zebra programme and grant award	2	1	2
Support of key stakeholders	Key stakeholders dissatisfied with programme outputs/objectives	2	1	2
Good project specification which meets LCC and Operator Partner and DfT Zebra funding objectives	Significant specification and design changes from concept/feasibility to development/delivery stage	2	1	1

50. In addition, there is now a low risk relating to the capital cost aspects of each of the projects as outlined in the Financial Case. All significant costs are now largely fixed in terms of written offers from key potential suppliers.

Non-Monetarised Impacts

Impact on Outcomes

51. It is considered that the above analysis from the Greener Bus tool only shows a partial picture of the effectiveness of the Leicester ZEBRA proposal in meeting the objectives of the DfT ZEBRA initiative, and of the overall value for money of the scheme.

52. There are significant non-monetarised benefits predicted which are set out below:

- a. Very likely to negotiate long term prices for renewable energy which are below the standard rates within the toolkit calculator. First Bus and Arriva both plan considerable electric bus expansion nationally and should be able to command

long term prices as attractive as currently indicated.

This could increase programme BCRs by upto 30% as shown in the sensitivity analysis above. This could readily be supplemented by depot energy capture systems (PV panels) linked to battery storage systems which directly charge the buses at night – all depots have large footprints and suitable garages on which to mount these panels.

- b. Predicted increase in passenger numbers brought about by the introduction of ZEBS in these three projects and associated improved perception of public transport. The new vehicles and wider measures are expected to improve passenger experience by:

- the significant uplift in quality of the buses
- the range of additional accessibility features
- the significant marketing programme associated with the programmes
- the complementary investments as part of the Enhanced Partnership package.

It is noted that Nottingham's Centrelink service saw a sustained increase in passenger numbers of 8% by moving to electric – without any other service changes.

- c. Over 35% of Leicester's travellers are either elderly or have a disability, making around 10million bus trips pa. They would therefore greatly benefit from these accessibility improvements to 30% of the fleet.
- d. Unlocking more private and other investment/revenue streams than currently planned. The ZEBRA operator investment will form a significant part of the Enhanced Partnership, increasing its investment from its planned £11m to £28m between 2021 and 2024.
- e. This should also have a significant impact on enabling the Council to push through its plans for Workplace Parking Levy, and the associated investment planned with this revenue stream on the bus network.
- f. Dovetailing with other ongoing and planned investment in bus priority, waiting infrastructure, park and ride sites and digital ticketing to give 'bus rapid transit' treatment to 21 routes. The integration of the two investments is very likely to give benefits greater than the individual sum of their parts. (This has been shown in other cities such as the Nottingham Derby Rd Demonstration Bus Scheme).
- g. Allow each of Leicester's operators to quickly escalate future investment in electric buses, using the technical supplier solutions and infrastructure investment they have adopted in this proposal. A third of Leicester's network will be electric by 2024, and it is anticipated that – with the planned Enhanced Partnership Scheme – this can readily move to over 60% by 2028.
- h. It enables more operators to tender for electric bus contracts in other nearby areas. This is particularly the case for the main smaller bus operator in Leicester–

Centrebus, bringing a level playing field to investment in this area.

- i. There are also noise reduction benefits from these buses. This will be particularly beneficial to residents living in the dense urban housing along each bus route within the city area, together with those living in flats within the city centre, particularly close to the bus stations. This benefit is hard to quantify but will have a meaningful impact on resident's lives.
- j. Reduction in other air pollution constituents which have a harmful impact on health. These are estimated annually as 44 tonnes of Nitrogen Oxide and 1.1 tonnes of PM2.5.

Impact on ZEBRA Objectives

53. Set out below is a summary of how this bid should significantly impact on the overall ZEBRA objectives.

To support the government's commitment to decarbonisation and to reduce the transport sector's contribution to CO2 emissions.

54. It is estimated that this investment will bring about a local saving of over 91 tonnes of CO2 within Air Quality Management Areas of Leicester. It will bring frequent electric buses to all 15 of Leicester's air quality management areas.

To support the roll-out of the 4,000 Zero Emission Buses

55. This investment will deliver 96 new electric buses to Leicester by 2024. Together with other investment that has already taken place or is already committed, the total electric bus fleet will be 132 by 2024, representing a third of the fleet employed across Greater Leicester.

To support bus manufacturers in the development of zero emission bus technology.

56. This bid will support three different bus manufacturers. All three will further develop their local supply chains and associated warranty and maintenance capabilities within the UK.

57. REDACTED

58. REDACTED

To support partnership working between Local Transport Authorities, bus operators, and other local stakeholders as set out in the National Bus Strategy.

59. This bid forms a significant part of Leicester's Bus Services Improvement Plan and associated Enhanced Bus Partnership – part of the National Bus Strategy. It brings together five local bus operators, with the bus investment matched by a significant programme of other investment designed to radically improve the bus offer to Leicester's travelling public – giving a sustainable alternative to using the car, facilitating green growth. It will also give the bus network greater commercial viability and accessibility to this growth for those without access to a car.

To understand better the challenges of introducing zero emission buses and supporting infrastructure to inform future government support for Zero Emission Buses.

60. This bid will further expand electric bus operation to another three bus depots in Leicester – 60% of its 5 depots – leaving just one remaining. The overall programme will have at least 4 different bus suppliers, each with different charging methods and bus types.

61. There will both double deckers and single deckers and will also cover a range of different route types – urban, longer distance and even operations in pedestrianised areas. It will also give experience of converting a whole depot and operator network to electric, together with operating contacted electric buses and mixed fleets.

62. Leicester is unique in having several main bus operators – so this bid will give experience of introducing across a range of operators within a small area and time period.

Impact on DfT Wider Objectives

63. The bid should also have a demonstrable impact on wider DfT objectives

Reducing Environmental Impact

- a. Will make a significant impact on air and noise quality on each main AQMA sub-area, with frequent electric buses on each AQMA corridor.
- b. Focussed on areas of dense housing, with schools and hospitals located on them.
- c. Visual, pedestrian and environmental impact on the City Centre – making it a more attractive place to work, live and shop following the pandemic.

Levelling Up

- d. Significant partnership local investment to complement and boost a range of secured and planned other investments. These are all within the draft Bus Services Improvement Plan/Enhanced Partnership.

- e. Assist sustainable regeneration and housing growth – there are proposed electric bus routes going through each of the designated housing and regeneration areas:
- Waterside Enterprise Zone
 - Abbey Meadows/National Space Centre
 - Hallam Fields
 - Ashton Green
 - Fosse Park
 - Optimus Point
 - Hamilton/Scraptoft
 - Meridian Business Park
- f. Improve sustainable accessibility to major employment and educational sites, particularly on the outer and inner orbitals:
- Beaumont Leys District Shopping Centre
 - Fosse Park shopping centre
 - Three Hospitals
 - De Montfort University
 - Leicester College
 - Samworth Brothers
 - Walkers
 - Crown Packaging
 - Bradgate Bakery
 - Pepsico
- g. Facilitate economic development:
- The local Leicester 2020-2036 plan is currently progressing through consultation but demonstrates where significant infrastructure for housing, commercial and transport is likely to take place in the next fifteen years.
 - This plan sets out the vision and objectives for the growth of the city with the locations identified for general development, the strategic development sites, the policies that will guide planning and how the plan will be delivered.
 - This clearly shows the need to energy upgrade investment within the vicinity of the First Bus depot, together with the potential increased demand for bus services in this area.
- h. Future potential electric vehicle demand from distribution clusters. Due to the proximity of Leicester to major distribution hubs at Castle Donington to the North and Lutterworth and Daventry to the South, Leicester does not have significant logistics fleet operations, but two distribution clusters are:
- Beaumont Park (North): Pepsico, Walkers

- Meridian Park (West): DHL, Royal Mail, Topps Tiles

It is considered that these locations will not place a potential strain on energy distribution to the proposed ZEBRA electric bus depots.

- i. Focus on routes to areas of multiple deprivation where health and productivity issues related to air quality are highest:

- Beaumont Leys
- Evington
- Belgrave
- Eyres Monsell

This focus means that intervention is targeted at areas in which environmental and socio-economic investment is most needed and will yield the greatest improvements

Improve Transport for the User

- j. Focus on higher use commercial bus routes – around 50% of users will be travelling on electric buses by 2024. This will significantly raise the profile of bus travel and passenger views on bus travel as we emerge from the pandemic
- k. Partnership desire to have an Enhanced Partnership with significant local investment, in order to maximise potential to access upcoming government grant opportunities. This will ensure that the upcoming growth of the conurbation will be able to take place in a sustainable and accessible manner.
- l. Focus on routes which go through or close to the three major hospitals: Leicester Royal Infirmary, General Hospital and Glenfield Hospital.
- m. Focus on routes which serve the 18 out of the 30 (60%) main secondary schools within Greater Leicester. This will provide cleaner and higher quality buses to pupils, maximising their chances of continuing to use the bus as they get older. Children are more prone to asthma and other breathing difficulties exacerbated by air pollution.
- n. Enables complete electric operations for all services from three operator depots : First Bus, Centrebus and Roberts, together with partial electrification of one of Arriva's two depots. This assists with operations and maximises early investment in depot changes and gride upgrades. With Stagecoach and Kinch depots being outside of Greater Leicester, this will leave just the Arriva Wigston depot to electrify, together with the remainder of its Thurmaston depot.
- o. Enables a third of Leicester's bus network to be fully electric by 2024 and a realistic Enhanced Partnership Plan to complete the rest of the network by 2030.
- p. Allows early delivery of the Greenlines project. This focuses on employment sites along the outer orbital, many of whom will be liable for workplace parking levy to help deliver the second stage of the Greenlines project.
- q. In addition, it should be noted that for First Bus and Arriva fleets, this investment will effectively cascade 90 Euro 3 diesel buses out of their wider national fleets.

- r. Enhanced PSVAR bus features to assist accessibility for those with various travel needs. The table below shows users views on these from a recent online survey with over 330 respondents.

Conclusions

- 64. The value for money of this proposed investment to the taxpayer has been assessed holistically taking into monetarised and non-monetarised costs and benefits, some broad financial indicators and a range of sensitivity tests.
- 65. The Greener Bus Tool gives a programme level BCR of 1.12, representing 'low' value for money.
- 66. There are a number of strong non-monetised benefits associated with the scheme, which are not captured within the GBT's BCR, including:
 - a. The operators are all currently purchasing renewable energy, improving the emissions savings and green credentials of the project. This would increase the BCR by around 30% if secured for each year of the bus life.
 - b. Anticipated increased patronage as a result of the improved passenger experience.
 - c. Reduction in noise pollution, materially improving the quality of life of local residents.
- 67. Overall, the programme is viewed as presenting **reasonable** value for money, particularly for two of the three proposed projects.
- 68. It is particularly good at meeting some of the key aims of the ZEBRA programme, namely:
 - a. REDACTED
 - b. Supporting the evolution of new technologies for this market – for the bus itself and its method of manufacturing
 - c. Rolling out a significant number of electric buses in a short space of time, building on previous investment and supported by future planned investment.
 - d. Having a significant focussed impact across three operators within a large complex urban setting - leading to a third of all buses being electric and half of all trips being made on electric buses by 2024.
 - e. Bringing a range of bus operators and the local authority into a strong workable delivering partnership, complemented by a package of other pro-bus measures designed to improve the viability of this significant operator and taxpayer investment.
- 69. In addition, this programme will assist in meeting the DfT's wider objectives relating to levelling up, reducing environmental impact and improving transport for the user:
 - a. Reduce air and noise pollution in dense urban areas with housings, schools and hospitals
 - b. Bring significant additional local and national investment to facilitate sustainable growth.
 - c. Bring significantly improved and more commercially viable buses to nearly half Leicester's bus users, particularly benefitting those with accessibility issues.

