Ricardo Energy & Environment

Derby EV Strategy & Electric Taxis

CAF Extension Report

Report for Derby City Council

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Executive summary

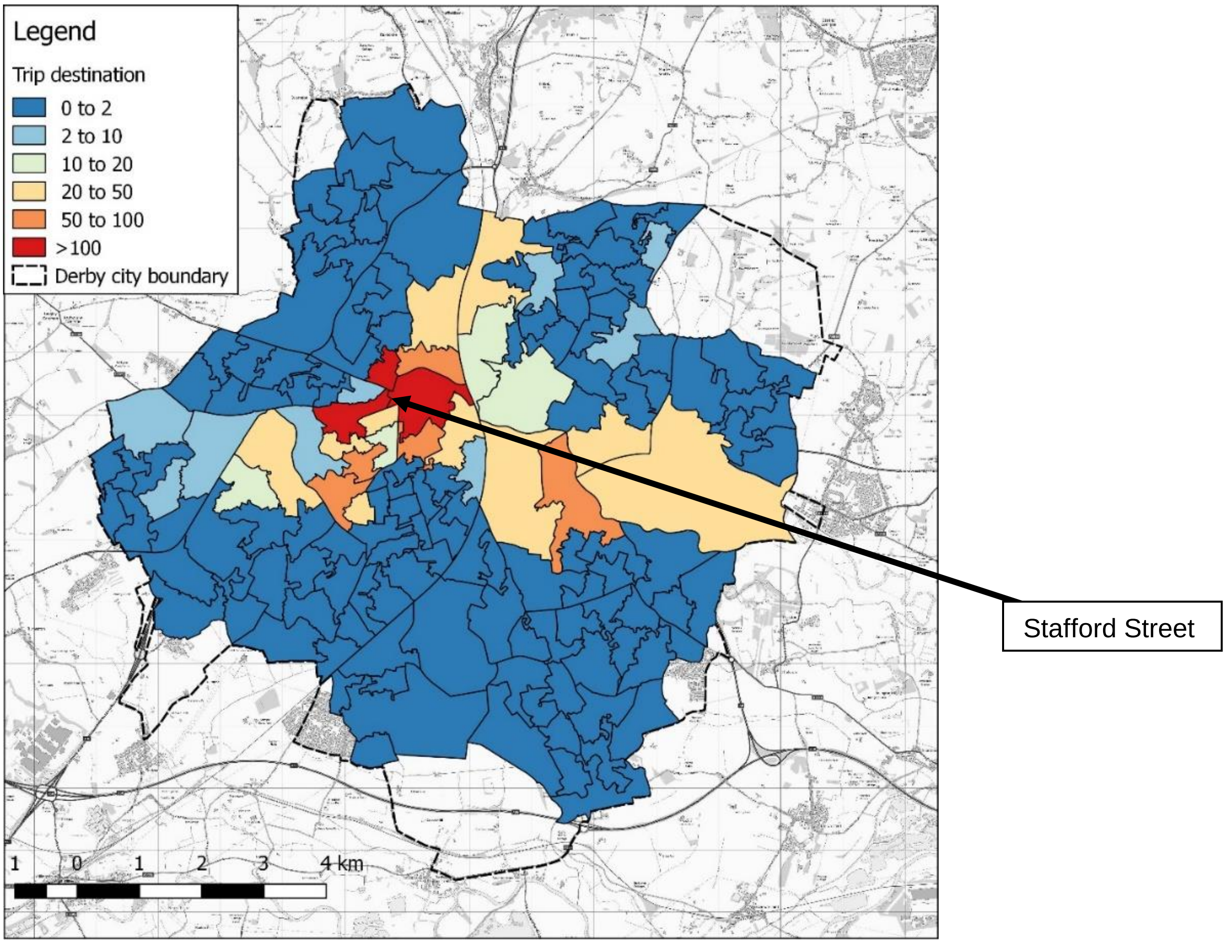
Derby City has been mandated by UK Government to introduce measures to address predicted exceedances in roadside NO_2. Derby City Council (DCC) is investigating measures that can be included within their bid for Clean Air Fund (CAF) funding. Derby's CAF proposal is intended to complement the preferred option to address roadside NO_2, mitigate any negative impacts of this scheme and reduce any risks associated with optimistic modelling assumptions, with the ultimate goal of improving air quality in Derby. DCC is exploring ways of facilitating the deployment of electric vehicles (EV) in various vehicle fleets in Derby, and the ways in which it can support Derby residents and businesses to transition from older, more polluting vehicles to zero emission vehicles.

DCC commissioned Ricardo to develop an EV charging infrastructure strategy for Derby City, and to assess the support that DCC can provide to the hackney taxi trade in Derby City to electrify their fleets – this analysis is available in a separate report entitled ***"Derby EV Strategy & Electric Taxis – Final Report"****.* The purpose of this report, "Derby EV Strategy & Electric Taxis – CAF Extension Report", is to provide additional analysis that focuses solely on the elements of charging infrastructure that can be included within DCC's bid for CAF funding. This includes an analysis of how the EV charging infrastructure strategy can lead to electrification of trips on Stafford Street, and an updated emissions and economic analysis of the charging infrastructure to be included in DCC's CAF bid.

A select link analysis was carried out for Stafford Street, which shows the origins and destinations of trips that pass through Stafford Street. This analysis was carried out for both the wider Derby area and within Derby City. A proportion of this traffic on Stafford Street will divert as a result of the proposed traffic management in the preferred option, which means that EV measures to address this element of the fleet will help to minimise vehicle emissions from re-routed traffic and will help to mitigate any negative air quality impact of the scheme on other roads. The results of the select link analysis show that a relatively high proportion of trips that go through Stafford Street originate from outside of Derby City (30.2% of trips), and that a very high proportion of trips culminate in the city centre (80.8% of trips). Figure 1 displays the destinations of trips passing through Stafford Street. Given that many vehicles end their journey in the city centre, provision of public charging in key parking locations in the city centre would facilitate use of zero emission vehicles and zero emission miles from plug-in hybrid vehicles (PHEVs) travelling through Stafford Street.

The analysis shows that a reduction in NO_X, PM_{10} and $PM_{2.5}$ along Stafford Street of 0.026, 0.0031 and 0.0018 tonnes respectively, would be enabled through an increase in the proportion of EVs in Derby to 6.8% of the vehicle fleet by 2025. Electrification of up to 10.8% of traffic on Stafford Street could be enabled through the implementation of the recommended charging infrastructure. A relatively high proportion of traffic on Stafford Street is made up of taxis (2-2.7%); charging infrastructure supporting an increase in electric taxis could lead to further emissions benefits on Stafford Street in addition to those from the general vehicle fleet. Additionally, there are overlaps between the origins of trips passing through Stafford Street with the recommended locations for on-street residential charging infrastructure – therefore deployment of that infrastructure would support EV adoption and usage along Stafford Street. A proportion of traffic on Stafford Street has a destination that appears to be business premises, supporting the installation of workplace charge points. Although the CAF application does not include support for workplace charging, the combination of domestic on-street charging and workplace charging will likely support more zero emission journeys.

Figure 1 Derby city trip destinations for journeys through Stafford Street



Emissions and economic impact assessments were carried out for the charge points proposed to be included in DCC's CAF bid. The number of charge points recommended to be included in DCC's CAF bid is presented in Table 1. This does not consider charge points for which DCC already has access to funding (i.e. workplace charge points from the Workplace Charging Scheme; a proportion of on-street residential charge points from the On-street Residential Charging Scheme; and 20 rapid charge points for taxis funded via Early Measures Funding and OLEV Go Ultra Low City Project funding with Nottingham City and Nottinghamshire County Councils); as such, the table below differs to the overall recommendation for charge points in Derby City, as outlined in the "Derby EV Strategy & Electric Taxis – Final Report" document. Please note that the labelling of the "Minimum", "Adequate" and "Target" scenarios refers to ratios of charge points to EVs and as such the provision of public charging infrastructure, rather than referring to "do-minimum" scenarios for the business case.

Table 1 Number of charge points recommended to be included in DCC's CAF bid

	Scenario 1: "Minimum"	Scenario 2: "Adequate"	Scenario 3: "Target"
Workplace	0	0	0
Public	45	75	113
Rapids	0	0	5
Residential – lamppost	64	74	94
Residential – dedicated	64	74	94
Total	**173**	**223**	**306**

The anticipated change in total emissions resulting from the scheme (charge point deployment) has been calculated. The emissions represent the change in total emissions per kilometre, resulting from the changes to passenger vehicles, assuming an average speed of 38 km/hr. Emissions are provided as an annual reduction in tonnes when compared with a 'do nothing' scenario (cumulative reduction provided in brackets), as shown in Table 2. An estimation of the reduction in emissions along Stafford Street has also been provided.

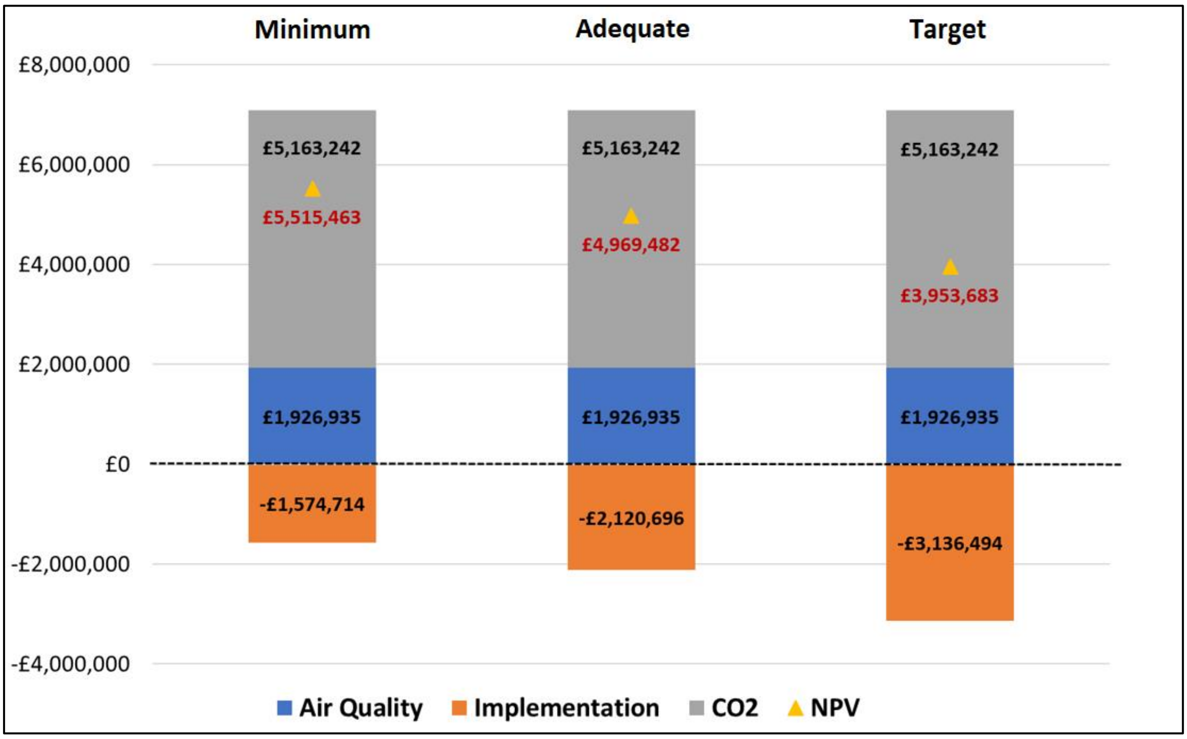
Table 2 Annual emissions reductions through increase in EV uptake compared to a "do nothing" scenario (brackets show cumulative electric vehicles and cumulative emission reductions)

Year	Number of vehicles	Across Derby (tonnes/year)			Stafford Street (tonnes/year)		
		NO_x	$PM_{2.5}$	PM_{10}	NO_x	$PM_{2.5}$	PM_{10}
2019	463	1.73	0.11	0.19	0.0021	0.00012	0.00020
2020	653 (1,116)	2.36 (4.10)	0.15 (0.26)	0.26 (0.45)	0.0029 (0.0050)	0.00016 (0.00028)	0.00028 (0.00049)
2021	837 (1,953)	2.82 (6.92)	0.19 (0.45)	0.34 (0.79)	0.0035 (0.0085)	0.00022 (0.00050)	0.00037 (0.00085)
2022	1,021 (2,974)	3.2 (10.1)	0.23 (0.68)	0.41 (1.19)	0.0039 (0.012)	0.00026 (0.00076)	0.00044 (0.0013)
2023	1,205 (4,179)	3.5 (13.6)	0.27 (0.95)	0.47 (1.67)	0.0043 (0.017)	0.00030 (0.0011)	0.00051 (0.0018)
2024	1,389 (5,568)	3.73 (17.4)	0.3 (1.25)	0.54 (2.21)	0.0046 (0.021)	0.00034 (0.0014)	0.00059 (0.0024)
2025	1,573 (7,141)	3.89 (21.2)	0.34 (1.59)	0.61 (2.82)	0.0047 (0.026)	0.00038 (0.0018)	0.00066 (0.0031)

The economic analysis of the EV charging infrastructure proposed to be included within DCC's bid for CAF funding shows the following: the scheme is forecast to result in positive benefits relating to carbon emissions and air quality, and these impacts are estimated to represent a monetary value of approximately £7m over a 10-year period; the scheme is forecast to result in negative impacts resulting from the costs of implementing the scheme, which range between approximately £1.6m ('Minimum') and £3.1m ('Target'). The results are displayed in Figure 2

The results indicate the EV charging infrastructure proposed to be included within DCC's bid for CAF funding would result in a positive Net Present Value (NPV) (i.e. the benefits for carbon emissions and air quality would outweigh the costs of implementing the scheme). The NPV can be seen to fall as the number of charging points, and subsequent costs, increase. However, this assumes the uptake of the scheme remains constant regardless of the level of investment in charging points – we have assumed differing ratios of chargers to EVs within our analysis, owing to these results. Therefore, deployment of more infrastructure, i.e. following the "Target" scenario, increases the likelihood that the benefits can be realised within the timeframe. It should also be noted that the upgrade costs (i.e. the cost of purchasing the electric vehicles) have not been factored into the assessment.

Figure 2 Results of economic analysis of EV strategy – 'Minimum', 'Adequate' & 'Target'



Overall, the implementation of the EV charging infrastructure proposed to be included within DCC's bid for CAF funding is forecast to have a positive impact on emissions and represent a positive NPV for the Council. Furthermore, the scheme would provide vital support to the City's broader package of low emission measures, the cumulative impact of which has not been considered in this assessment. The implementation of the 'Target' scenario is also expected to increase the zero-emission mileage driven within Derby City by allowing commuters to charge their vehicles within Derby, leading to further air quality benefits.

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1 Introduction

1.1 Background

The UK Government has mandated five cities to introduce measures to address roadside nitrogen dioxide (NO_2) in areas where air pollution breaches legal limits (as part of the 'First Wave' plan for tackling roadside NO_2 concentrations). Derby City was identified as one of these cities, and as such Derby City is required to introduce measures to address predicted exceedances in roadside NO_2.

A Clean Air Zone (CAZ) is an area where targeted action is taken to reduce all types of air pollution, including NO_2 and particulate matter (PM), and a CAZ includes a charging element. The UK plan for CAZs also states that non-charging solutions can be adopted, with or without a specified CAZ, if such solutions can be shown to deliver compliance with NO_2 limits and at least as quickly as any charging CAZ option. A £220 million Clean Air Fund (CAF) has been made available by government to help fund measures which mitigate the impact of any plans to tackle the predicted exceedances. The CAF is managed by the Government's Joint Air Quality Unit (JAQU).

Derby City Council (DCC) is investigating measures that can be included within their bid for CAF funding. Derby's CAF proposal is intended to complement the preferred scheme to address roadside NO_2, mitigate negative impacts of the measures implemented from the implementation fund and manage any risk associated with uncertainly in the modelling assumptions, with the ultimate goal of improving air quality in Derby. As part of this package of measures, DCC is exploring ways to facilitate the deployment of electric vehicles (EV) in various vehicle fleets. EVs have clear air quality benefits when compared with internal combustion engine vehicles (ICEV), in that they produce zero tailpipe emissions.

DCC commissioned Ricardo Energy & Environment ('Ricardo') to carry out an analysis on the support that DCC can provide to residents and businesses in Derby City to transition from petrol and diesel vehicles to ultra low emission vehicles (ULEV). Ricardo undertook an analysis specific to Derby City, broadly divided into two areas: the development of an EV charging infrastructure strategy for Derby City up until 2025; and the scoping of support that DCC can provide to the hackney taxi trade in Derby to transition to electric taxis (this analysis is available in a separate report entitled "***Derby EV Strategy & Electric Taxis – Final Report***").

1.2 Purpose of CAF Extension Report

The purpose of this CAF extension report is to provide additional analysis and a summary report solely focused on the elements of the "Derby EV Strategy & Electric Taxis" that can be included in DCC's CAF bid. This report intends to provide additional evidence in support of the recommended deployment of charging infrastructure in Derby City, specifically related to the area that will be the focus of DCC's CAF bid, i.e. Stafford Street.

This report utilises results of a link analysis on Stafford Street to describe how the recommendations in the Derby EV charging infrastructure strategy can contribute to emissions reductions on Stafford Street. We also outline the emissions reductions that can be expected on Stafford Street as a result of the implementation of charging infrastructure. Additionally, we produce an update of the business case analysis that was undertaken within the Derby EV Strategy & Electric Taxis report to focus specifically on the charging infrastructure that can be included in DCC's CAF bid, making note of charging infrastructure that already has funding allocated or that can be funded through existing governmental funding streams.

1.3 Key Information from Derby EV Strategy & Electric Taxis Report

In January 2019, there were just 18 publicly available charging sockets in Derby, equating to one charging socket for every 59 EVs. This is far below the UK average of one charging socket for every 9.6 EVs. In order to encourage and support uptake, and increased usage, of EVs, a comprehensive network of public charging needs to be established in Derby. For Derby to achieve EV uptake in-line with the 'Road to Zero' targets, penetration of ULEVs needs to correspond to our "high uptake" penetration scenario (corresponding to 16.8% of all vehicle sales in 2025) – this equates to approximately 8,000 vehicles in Derby City in 2025, and this does not include vehicles from neighbouring regions travelling to Derby City.

A range of ratios was used in the analysis to provide an indication of the charging infrastructure requirements in Derby City to 2025. Scenarios were developed that covered ratios of 1 public charger to every 10, 15 and 25 EVs. For the "high uptake" scenario, this provided a range of between 320 public chargers (for 1:25) and 800 public chargers (for 1:10). Derby City's recommended public charging infrastructure strategy covers all types of public charging and caters to different use cases and user groups that would be expected to make use of it. The recommendation is to deploy the public charging infrastructure in Derby as shown in Table 3.

With respect to the labelling of the 'Minimum', 'Adequate' and 'Target' scenarios, these specifically refer to the charge point to EV ratios, rather than referring to terminology related to the business case for the vehicles (e.g. "do-minimum"). The 'Minimum' scenario represents the minimum amount of charging infrastructure that should be installed to support an expected 8,000 EVs in Derby City by 2025; similarly, the 'Adequate' scenario accounts for an adequate supply of infrastructure to support 8,000 EVs in Derby City by 2025. The 'Target' scenario represents the ratio of charge points to EVs that would be expected to put Derby City's infrastructure provision on track with the UK.

Table 3 Charger type installations targets for Derby by 2025 by socket number

Charger Type	Minimum	Adequate	Target
Workplace 7-11kW (should encourage smart chargers)	200	335	500
Public Fast 7-22kW	90 (45 dual socket)	150 (75 dual socket)	225 (113 dual socket)
Rapid DC 50-150kW (results and pricing provided for 50kW)	20	20	25
On-Street Residential 3-7kW (should be smart)	160 (80 lamp post; 80 dedicated dual socket)	180 (90 lamp post; 90 dedicated dual socket)	220 (110 lamp post; dedicated 110 dual socket)
Total	460 (320 + 120 taxi on-street residential + 20 on-street residential oversupply)	685 (535 + 120 taxi on-street residential + 30 on-street residential oversupply)	970 (800 + 120 taxi on-street residential + 50 on-street residential oversupply)

In the absence of clear consensus and evidence on the most appropriate ratio of chargers to EVs to support strong EV adoption and usage (based on our review of international literature), we recommend that Derby follows the 'Target' number of charge points. This will help ensure that the EV charging infrastructure is seen to be available for potential EV adopters, helping to alleviate concerns over its availability and providing additional confidence to maximise use of EVs and zero emission miles driven in Derby. It will also bring Derby in line with the overall UK ratio of 9.6 EVs per charging socket and representing the most significant opportunity to achieve the mid-term targets outlined in the Government's 'Road to Zero' strategy.

2 Derby Clean Air Fund Bid – Additional Analysis

This section provides the additional analysis undertaken to support DCC's CAF bid for charging infrastructure. Whilst the overall EV charging infrastructure strategy is outlined in the "Derby EV Strategy & Electric Taxis" document, this section provides the supporting analysis and commentary specific to Derby's CAF bid. We provide the analysis of results on the select link analysis on Stafford Street, and we display the expected reduction in emissions as a result of increased EV traffic on Stafford Street. We then provide the emissions and economic assessments for the charging infrastructure that can be installed via Derby's CAF bid, ignoring charging infrastructure that can be installed via other funding streams.

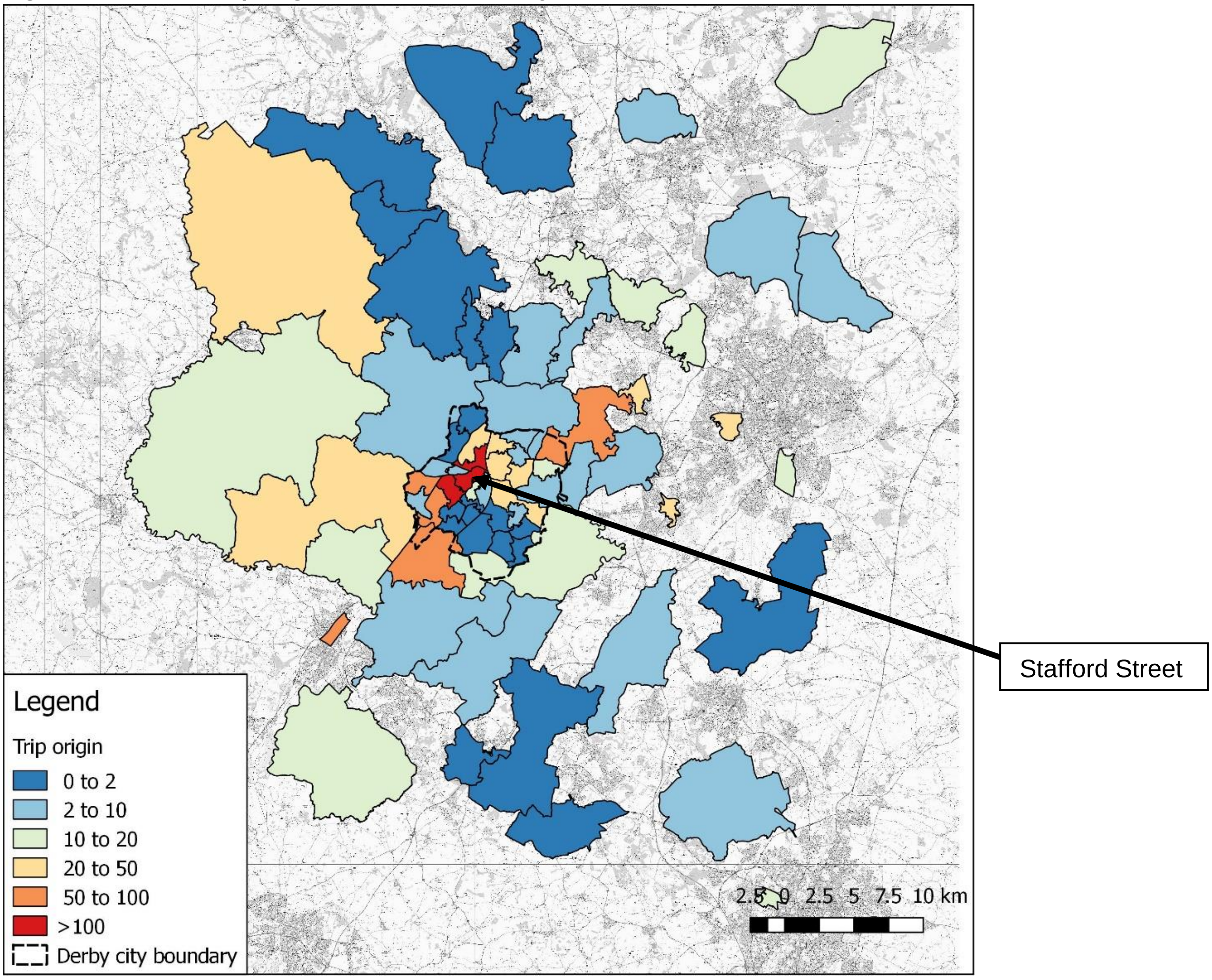
2.1 Select Link Analysis

2.1.1 Stafford Street Select Link Analysis

A select link analysis was undertaken in order to focus on the trips that occur in Derby and current use of vehicles on Stafford Street. The select link analysis calculates the number of journeys that pass through a certain location, in this case Stafford Street. The origin and destination of these journeys can be analysed to provide an indication of where the demand is located for vehicle journeys on Stafford Street. Following the implementation of the traffic management elements of Derby's preferred scheme to achieve compliance on Stafford Street, any measures that support a change to EVs will also provide benefits by reducing the risk of any air quality disbenefits that arise from the associated increases in traffic on the alternative route choices for diverted vehicles.

Firstly, it can be seen in the middle layer super output area (MSOA) analysis displayed in Figure 3 that a significant proportion of trips that use Stafford Street originate from outside Derby City (30.2% of trips). It can be assumed that, as Stafford Street is in the western portion of the city centre, a higher proportion of the journeys that use this road originate from this side of the city.

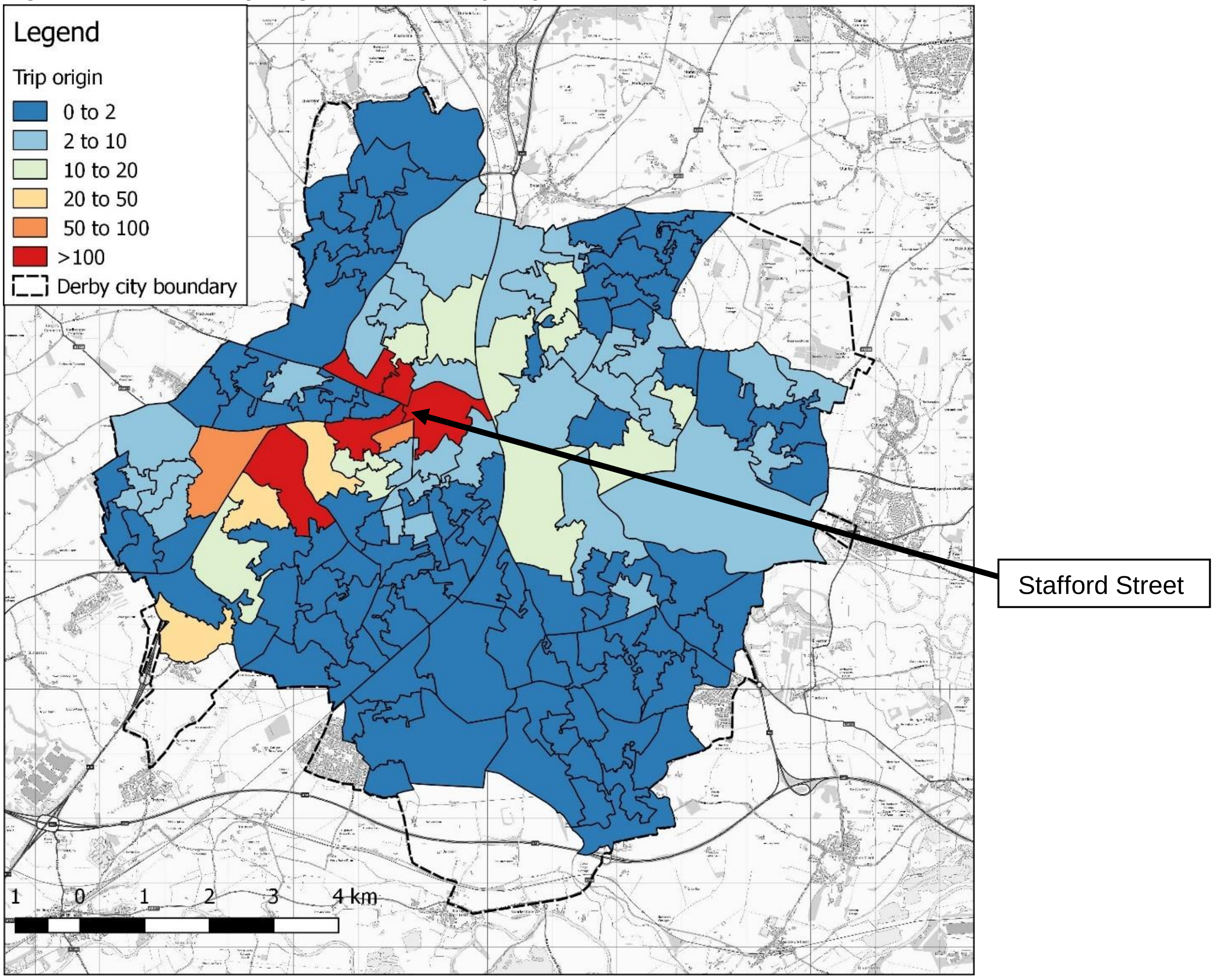
Figure 3 Number of trip origins for the wider Derby area MSOAs



With respect to the lower layer super output area (LSOA) analysis on the city centre-originating trips (shown in Figure 4) the highest proportion of trips originate within close proximity to Stafford Street (overall, 80.8% of trips going through Stafford Street have an origin within Derby City boundary). Smaller proportions of trips using this road originate from sectors of the city that are further away from the location.

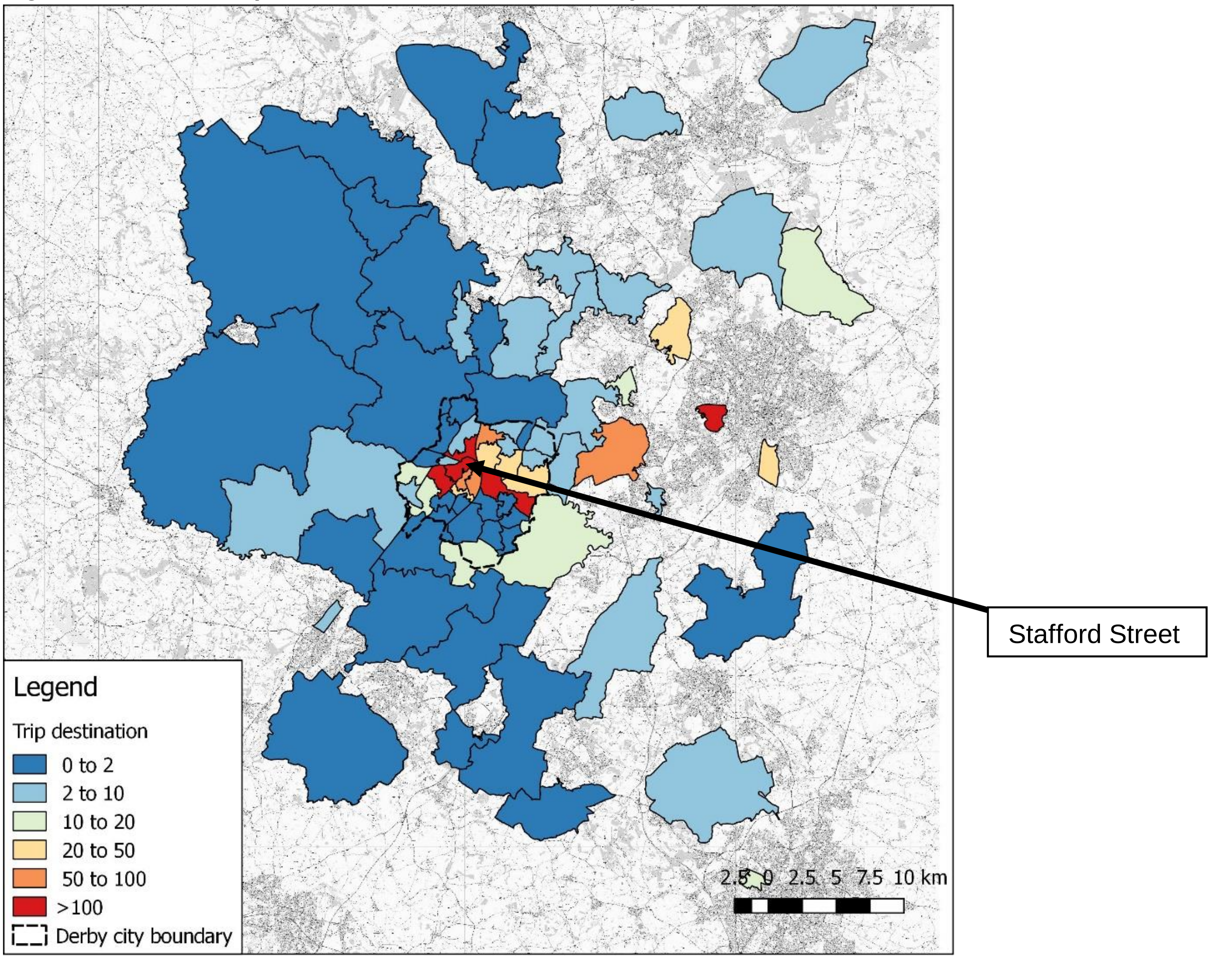
Many of the journey origins in Figure 4 coincide with areas that have no or very limited off-street parking opportunities (hence all residential parking takes place on-street) and were therefore focus areas for the installation of on-street charging infrastructure within the EV charging infrastructure strategy. This is particularly the case for the western part of Derby where the number of journey origins is >100 in some places. This is important for the trip origin data since many trips begin at home – for these to be electrified there must be available charging infrastructure, which is a challenge in areas with on-street parking.

Figure 4 Number of trip origins for the Derby City area LSOAs.



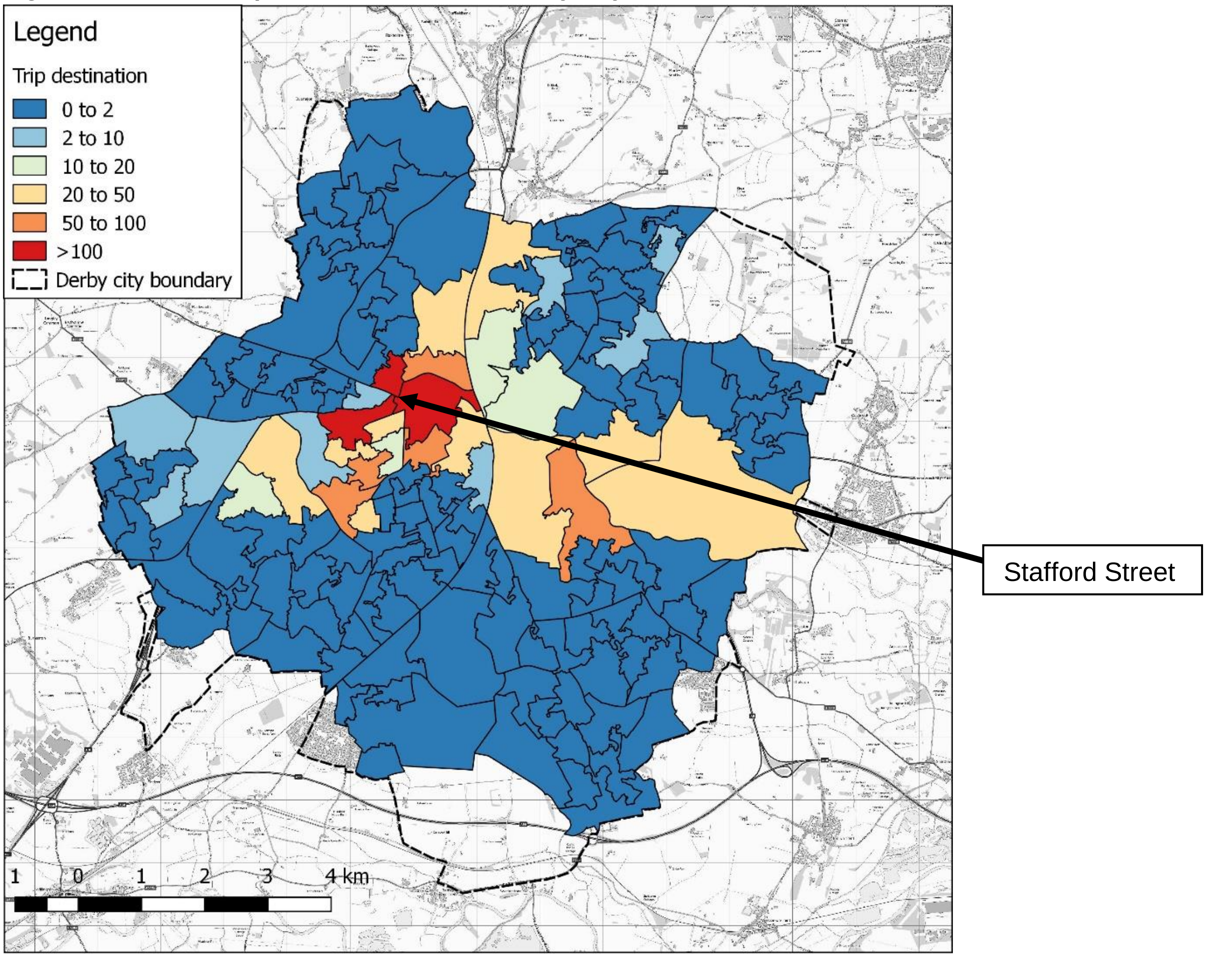
The patterns seen for the origins of trips are not reflected with the destination data for the journeys using Stafford Street. Figure 5 shows the density of destinations in the wider area of Derby, using the MSOA analysis. There is clearly a high density of destinations in the centre of Derby; however, the higher proportion of origins to the west of the city is not reflected in the destination data. Instead, many of the journeys have destinations in or near Nottingham. This can be seen in Figure 5.

Figure 5 Number of trip destinations for the wider Derby area MSOAs.



Of the journeys that have destinations in the city, using the LSOA analysis it can be seen that there is a greater tendency for journeys to finish in the centre of the city, as seen in Figure 6. Again, there are smaller proportions of journeys to the south of the city that use Stafford Street. A moderately high number of journeys end in the Pride Park area, possibly suggesting higher usage of the park and ride location.

Figure 6 Number of trip destinations for the Derby City area LSOAs.



It is clear from Figure 3 through Figure 6 that many of the journeys which use Stafford Street have origins and / or destinations in the city centre (36%). This is the only location that is common amongst both the origin and destination of the journeys, and therefore is a key focus area for any intervention to promote low emission transport alternatives.

In the previous study completed by Ricardo for DCC, it was recommended that a range of city centre car parks should be used to located public charging infrastructure. This infrastructure is therefore well-targeted to the journeys through Stafford Street. Table 4 shows the potential for these chargers to electrify traffic on Stafford Street. For this analysis, it is assumed that the chargers are used for 12 hours per day and that each vehicle has a dwell time of 2hrs; and that all the vehicles using the chargers use Stafford Street either before or after their charging session. This therefore presents an optimistic scenario where the charging installations are as effective as possible. However, as in reality not all EVs coming to the city centre will use public charging, and many of the locations recommended for chargers are in the areas of highest O/D activity for Stafford Street, this may be representative.

Table 4 Potential for traffic electrification on Stafford St enabled by city centre charger installations.

Total journeys on Stafford St per day	No. City Centre Charge points	Max city centre journeys electrified per day	Max Stafford Street traffic electrified by public chargers	Traffic electrified from taxi strategy
4,479	35	210	4.7%	1 – 1.35%
	55	330	7.3%	
	80	480	10.6%	

As the traffic on Stafford Street has a high proportion of taxi usage (2-2.7% of traffic), there is a potential for a further increase in the proportion electrified traffic. This is due to the implementation of the taxi strategy in Derby which states that 50% of the taxis should be electrified by 2025.

There are parallels between the recommendations for infrastructure provision for electric taxis and the analysis presented here. Firstly, many of the taxi drivers live in areas with a relatively high proportion of origins and destinations for Stafford Street journeys. Therefore, the provision of on-street charging in these locations will enable electrification of these journeys by allowing them to begin their shift with a full charge. Secondly, the recommended provision of rapid chargers is focused near taxi ranks which are all centrally located. This is where the majority of journeys passing through Stafford Street originate and finish. Therefore, charging provision focussed in these areas for the taxis further improves the potential emissions reductions.

2.1.2 Businesses in Derby

The destination point of some journeys may be a business location. This could be for commuting purposes, if the traveller works there, or for leisure purposes if it is a retail business. These business locations should be focussed on for workplace chargers if they are the destination of many journeys, which complements the findings and the research on charging infrastructure for large businesses in Derby City undertaken in the "Derby EV Strategy & Electric Taxis" report.

Figure 7 and Figure 8 show this correlation for Derby city centre and the surrounding areas. There is a high number of businesses (the majority of which are SMEs, which can be disproportionately affected by policies related to clean vehicles, and as such may need infrastructure support) to the north west of Derby; however, these are not matched with high journey destinations. The locations where there are both high numbers of businesses and high journey destinations are all in the city centre, as shown in greater detail in Figure 8. These locations should therefore be targeted for workplace chargers in order to further reduce emissions on Stafford Street due to commuting and leisure activities taking place in these business locations.

In the development of the EV charging infrastructure strategy, we engaged with a number of local employers. These were all located within the Derby city area and likely account for a substantial proportion of the destination data presented here; however, most of them were large organisations and as only the number of businesses is considered here, not the size, these are underrepresented in this analysis (as it focusses on overall number of businesses). Each of these employers highlighted the importance of workplace charging and their willingness to work with the council to provide a charging solution to their employees who use EVs. The locations of the employers that we engaged with during the development of the EV charging infrastructure strategy are marked with stars in Figure 8 (these comprise Derby Hospital, Derby University, Derby Police Stations, Intu Shopping Centre, RTC Business Park and Rolls Royce).

Figure 7 Number of businesses over-laid with journey destinations for MSOAs in the Derby wider area.

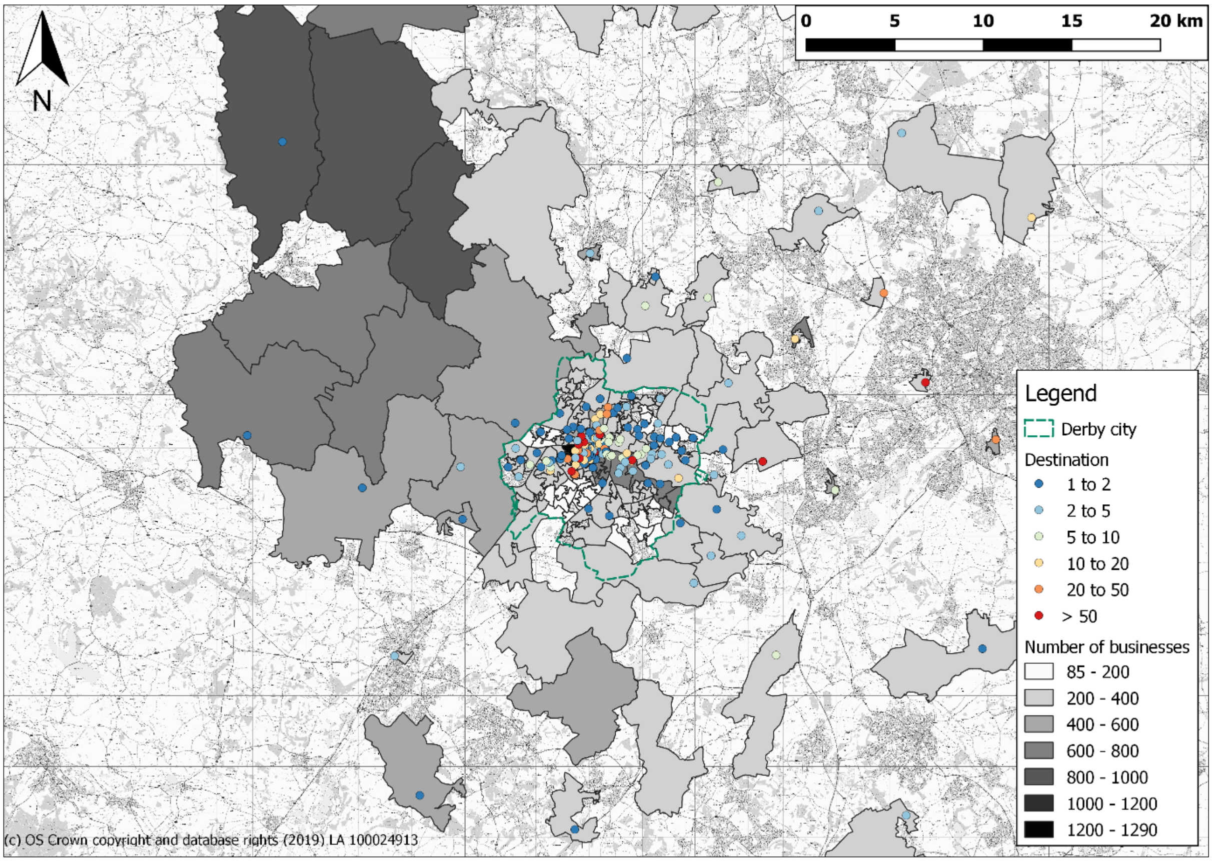
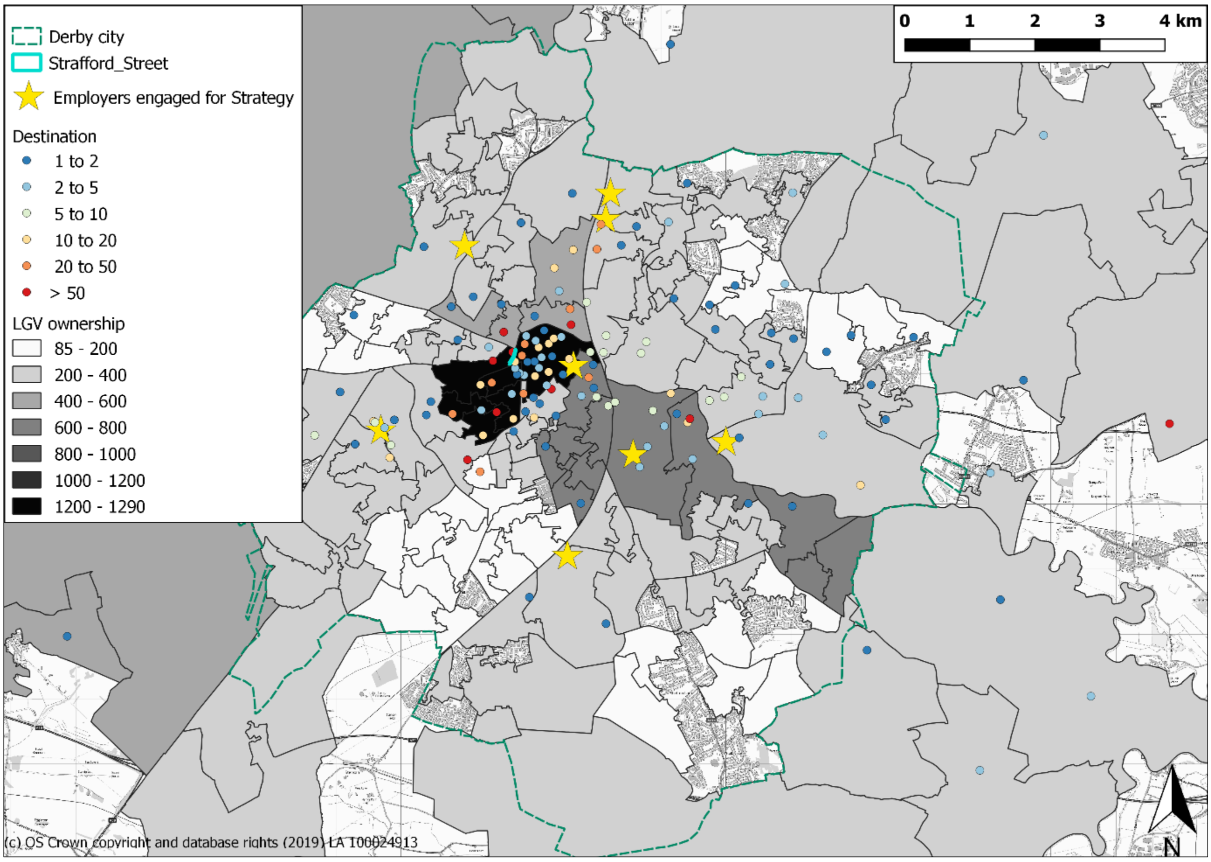


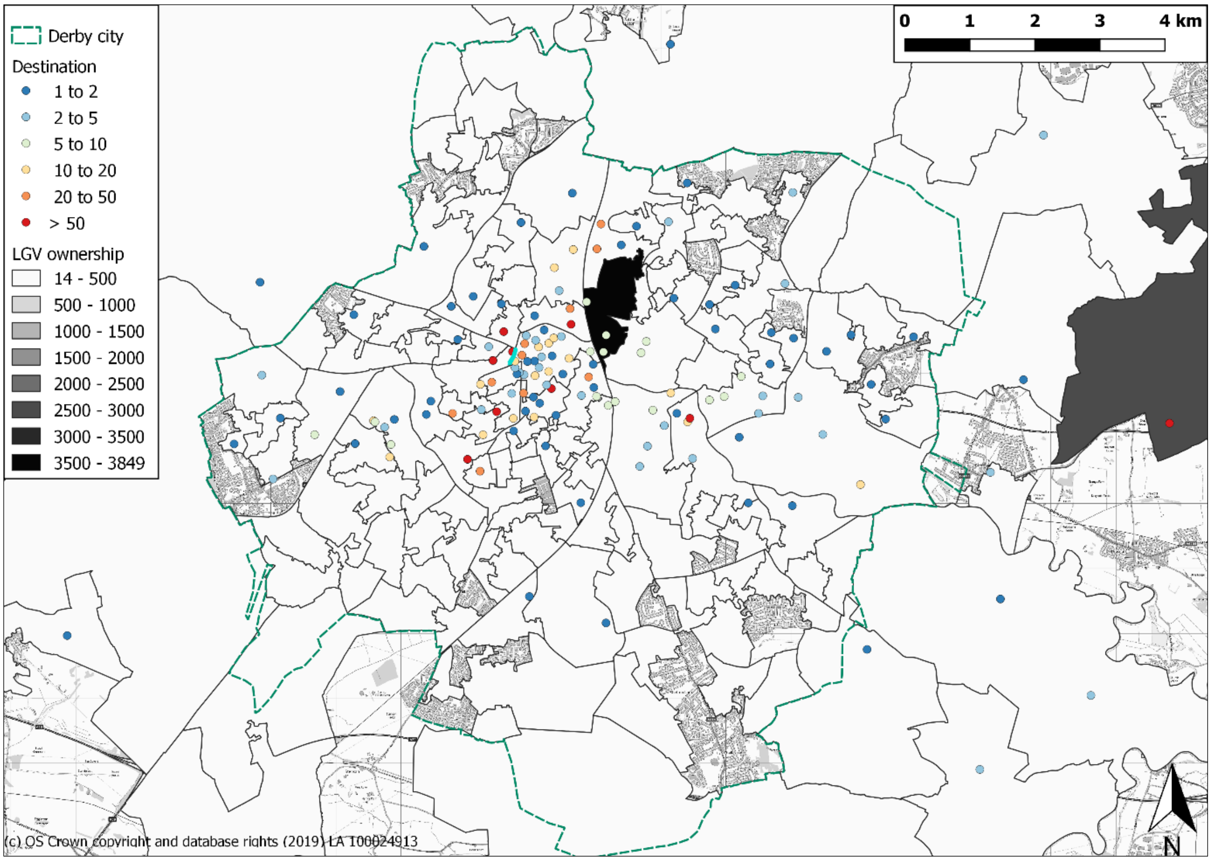
Figure 8 Number of businesses over-laid with journey destinations for LSOAs in the Derby City area.



2.1.3 Light Goods Vehicle Analysis

The light goods vehicles (LGV) operating in Derby are generally located in one of two locations, either to the east of the city or near to the railway in the north of the city. Neither of these locations have a high proportion of origins or destinations for journeys through Stafford Street, implying that LGVs are only a small proportion of the traffic there (although these could the registration locations for a number of lease vehicles which operate from businesses scattered around the city). Therefore, focus should be placed on the role passenger vehicles and other vehicle classes can play in reducing the NO_2 emissions on Stafford Street. However, the provision of a small number of rapid chargers on key strategic roads in Derby would provide support to fleet vehicles operated in shift patterns, such as LGVs. Figure 9 displays LGV ownership in Derby over-laid with origin data for journeys that use Stafford Street.

Figure 9 LGV ownership in Derby over-laid with origin data for journeys that use Stafford Street



2.2 Emissions Analysis

The reduction in emissions arising from the increased adoption of EVs in Derby can be directly calculated as the avoided emissions arising from displaced conventional vehicles. The emissions reduction which would be expected on Stafford Street each year to 2025 is shown in Table 5. This is lower for the traffic management scenario due to the lower amount of traffic overall in this scenario.

Table 5 Reduction in emissions (tonnes/year) (Stafford Street only, 2020 Base)

Year	2019	2020	2021	2022	2023	2024	2025
No. EVs	**463**	**653**	**837**	**1021**	**1205**	**1389**	**1573**
Baseline Scenario (tonnes/year)							
NOx	0.0021	0.0029	0.0035	0.0039	0.0043	0.0046	0.0047
PM2.5	0.0001	0.0002	0.0002	0.0003	0.0003	0.0003	0.0004
PM10	0.0002	0.0003	0.0004	0.0004	0.0005	0.0006	0.0007
Traffic Management Scenario (tonnes/year)							
NOx	0.0010	0.0014	0.0016	0.0019	0.0020	0.0022	0.0023
PM2.5	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002	0.0002
PM10	0.0001	0.0001	0.0002	0.0002	0.0002	0.0003	0.0003

The cumulative emissions reduction in tonnes to 2025 is shown in Table 6. This analysis is further explored in Section 2.3.3.

Table 6 Cumulative reduction in emissions (tonnes) (Stafford Street only, 2020 Base)

Year	2019	2020	2021	2022	2023	2024	2025
Baseline Scenario (tonnes)							
NOx	0.0021	0.0050	0.0085	0.0124	0.0167	0.0212	**0.0260**
PM2.5	0.0001	0.0003	0.0005	0.0008	0.0011	0.0014	**0.0018**
PM10	0.0002	0.0005	0.0009	0.0013	0.0018	0.0024	**0.0031**
Traffic Management Scenario (tonnes)							
NOx	0.0010	0.0024	0.0040	0.0059	0.0079	0.0101	**0.0123**
PM2.5	0.0001	0.0001	0.0002	0.0004	0.0005	0.0007	**0.0008**
PM10	0.0001	0.0002	0.0004	0.0006	0.0009	0.0012	**0.0015**

2.3 Business Case Analysis

2.3.1 Overview of Existing Funding Streams

DCC has access to a number of funding streams to fund charging infrastructure in Derby City; as such, a number of the charge point recommendations made within the “Derby EV Strategy & Electric Taxis” document can be funded via other means. This is valid for:

- Workplace Charging Scheme (WCS) – this scheme is available to employers seeking to facilitate the rollout of EV charging infrastructure, and as such this charging infrastructure (and the associated benefits) comes at no additional cost to DCC; however, DCC should have a coordination role to ensure that businesses in Derby City make use of the scheme.
- On-street Residential Chargepoint Scheme (ORCS) – this scheme funds up to 75% of the capital costs of on-street residential charge points (with at least 25% match funding provided by the council), up to a project cap of £100k. Considering the 25% match funding the council would have to provide (approximately £33k), using the costs outlined in Section 2.3.4 below we have estimated that this can provide for 16 lamp post and 16 dedicated charge points, so these have been removed from consideration for the CAF bid.
- Early Measures Funding – DCC was successful in receiving Early Measures Funding to install 20 rapid charge points for the use of electric taxis, and as such these have been removed from consideration for the scenarios below. The ‘Target’ scenario includes 5 additional rapid charge points, and as such these are considered within the business case analysis.

2.3.2 Methodology and Charge Point Scenarios

The following provides an assessment of the emissions and economic impact of the proposed EV charging infrastructure strategy for Derby in support of the business case for the scheme, focusing solely on the charging infrastructure that can be included within DCC's CAF bid. The assessment assumes the conversion of 7,141 vehicles in Derby from existing non-compliant diesel or petrol vehicles to EVs (i.e. not considering EVs already deployed in Derby City). To support this conversion, the assessment has considered several scenarios for the installation of charging points. The numbers of charge points included in this business case analysis are presented in Table 7. As previously mentioned, the labelling of the "Minimum", "Adequate" and "Target" scenarios refers to ratios of charge points to EVs and as such the provision of public charging infrastructure, rather than referring to "do-minimum" scenarios for the business case.

Table 7 EV charge point scenarios

	Scenario 1: "Minimum"	Scenario 2: "Adequate"	Scenario 3: "Target"
Workplace	0	0	0
Public	45	75	113
Rapids	0	0	5
Residential – lamppost	64	74	94
Residential – dedicated	64	74	94
Total	**173**	**223**	**306**

The impact on pollutant emissions of changing the existing vehicle fleet, by replacing non-compliant diesel and petrol vehicles with electric vehicles over a period of seven years (2019 – 2025), was calculated using the Emission Factor Toolkit (EfT v.8.0.1). The assessment includes the calculation of reduced emissions of nitrogen dioxide (NO_2) and particulate matter (PM_{10} and $PM_{2.5}$).

The economic analysis considers the costs associated with the purchase, installation and operation of the charging points and the economic impacts relating to carbon emissions and air quality, over a 10-year period, focusing solely on the charge points that can be included in DCC's CAF bid. These allow the estimation of the Net Present Value (NPV) – an indication of the overall economic value of the scheme – allowing for the potential positive and negative effects.

2.3.3 Emissions assessment

The EV charging infrastructure strategy is intended to promote and support the uptake of electric vehicles in Derby. The following provides an indication of how the changes to the vehicle fleet, over a seven-year period, will affect vehicle emission quantities.

The change in total emissions resulting from the scheme has been calculated using the estimated Euro splits and emission factors detailed in EFT v.8.0.1. The emissions represent the change in total emissions per km, resulting from the changes to passenger vehicles, assuming an average speed of 38 km/hr (average speed across all modelled links in the Derby domain). Emissions are provided as an annual reduction in tonnes (cumulative reduction provided in brackets), as shown in Table 8. An estimation of the reduction in emissions along Stafford Street has also been provided.

Table 8 Impact of the EV charging infrastructure strategy on total annual NOx and PM emissions (tonnes) compared to a "do nothing" scenario (brackets show cumulative electric vehicles and cumulative emission reductions)

Year	Number of vehicles	Across Derby			Stafford Street		
		NOx	$PM_{2.5}$	PM_{10}	NOx	$PM_{2.5}$	PM_{10}
2019	463	1.73	0.11	0.19	0.0021	0.00012	0.00020
2020	653 (1,116)	2.36 (4.10)	0.15 (0.26)	0.26 (0.45)	0.0029 (0.0050)	0.00016 (0.00028)	0.00028 (0.00049)
2021	837 (1,953)	2.82 (6.92)	0.19 (0.45)	0.34 (0.79)	0.0035 (0.0085)	0.00022 (0.00050)	0.00037 (0.00085)
2022	1,021 (2,974)	3.2 (10.1)	0.23 (0.68)	0.41 (1.19)	0.0039 (0.012)	0.00026 (0.00076)	0.00044 (0.0013)
2023	1,205 (4,179)	3.5 (13.6)	0.27 (0.95)	0.47 (1.67)	0.0043 (0.017)	0.00030 (0.0011)	0.00051 (0.0018)
2024	1,389 (5,568)	3.73 (17.4)	0.3 (1.25)	0.54 (2.21)	0.0046 (0.021)	0.00034 (0.0014)	0.00059 (0.0024)
2025	1,573 (7,141)	3.89 (21.2)	0.34 (1.59)	0.61 (2.82)	0.0047 (0.026)	0.00038 (0.0018)	0.00066 (0.0031)

The results indicate that if the EV charging infrastructure strategy achieves an increase of 7,141 electric vehicles in Derby, over a seven-year period, the scheme has the potential to result in the cumulative reduction in NOx, PM_{10} and $PM_{2.5}$ emissions of up to 21.2, 2.8 and 1.6 tonnes, respectively, across the city. It is estimated this change would result in a reduction in emissions of NOx, PM_{10} and $PM_{2.5}$ along Stafford Street of 0.026, 0.0031 and 0.0018 tonnes, respectively, during this period.

As the EV charging infrastructure strategy will be city-wide, the benefits of the scheme, including a reduction in background pollutant concentrations, will be felt across Derby.

2.3.4 Economic assessment

The following provides a summary of the forecast economic effects associated with the EV charging infrastructure strategy. This assessment provides an estimation of impacts over a 10-year period, between 2020 and 2030. The assessment includes several assumptions on the uptake and costs of the scheme:

- There is assumed to be an even split of diesel and petrol vehicles replaced by EVs each year.
- It is assumed the older vehicles will be replaced first by the scheme (these assumptions are consistent with the assumptions in the above emissions assessment).
- It was assumed the costs associated with installation and operation of workplace charging points would be absorbed by businesses, and thus have not been factored into the assessment.
- The assessment excludes costs for charging points for which finance has already been secured (i.e. focuses solely on charging infrastructure for DCC's CAF bid).
- The analysis does not consider the economic effects for the vehicle owners, including the cost of purchasing and operating the vehicles.

Estimations of capital expenditure (CAPEX) and operating expenditure (OPEX) for EV charging infrastructure were identified through discussions with suppliers (see Table 9) and have been factored into the economic analysis of the three scenarios (see Table 10). The results of the economic analysis of the three scenarios are presented in Figure 10.

Table 9 CAPEX & OPEX costs for EV charging infrastructure

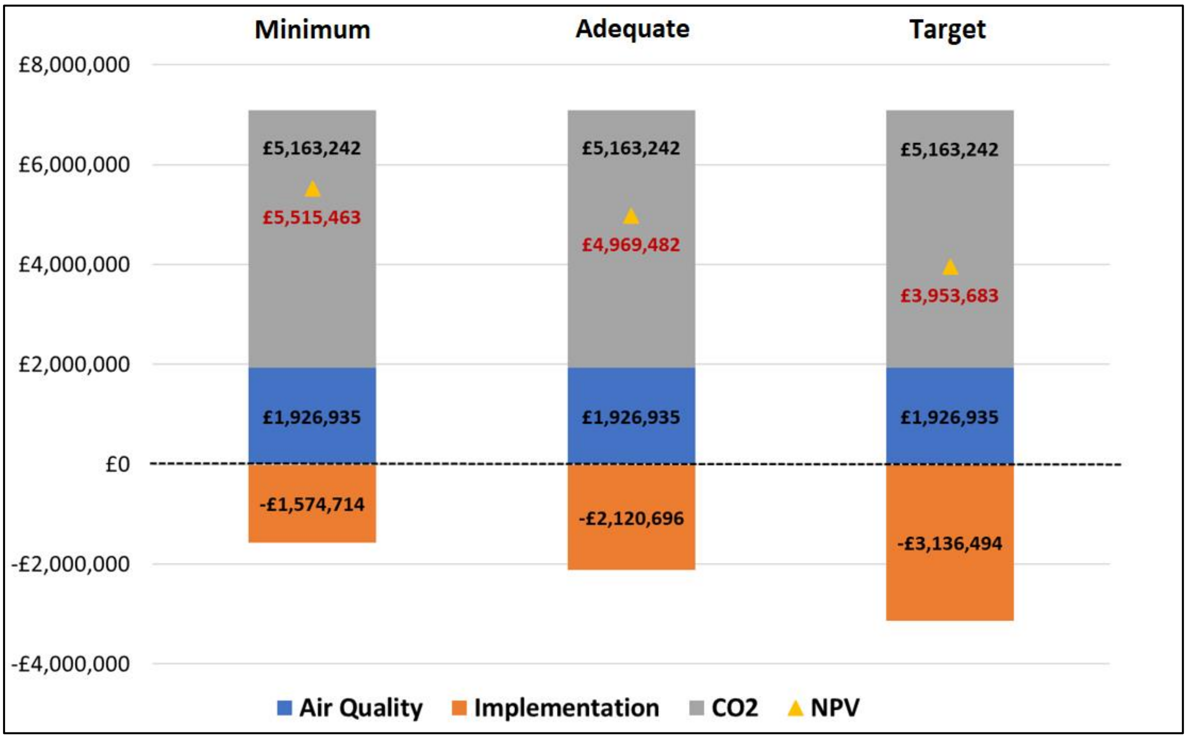
	Public (11 kW)		Rapids (50 kW)		Residential - lampposts (3 kW)		Residential - dedicated (7 kW)	
	CAPEX	OPEX	CAPEX	OPEX	CAPEX	OPEX	CAPEX	OPEX
Unit Cost	£1,900	-	£20,000	-	£750	-	£1,500	-
DNO* connection	£1,500	-	£5,000	-	£1,000	-	£1,500	-
Install / connection	£3,000	-	£6,000	-	£220	-	£3,000	-
Signing / lining	£2,000	-	£2,000	-	N/A	-	N/A	-
Maintenance per year	-	£350	-	£750	-	£250	-	£250
Back office per year	-	£150	-	£240	-	£150	-	£150

*** Distribution Network Operator**

Table 10 CAPEX & OPEX costs by scenario

Charger type	"Minimum"		"Adequate"		"Target"	
	CAPEX	OPEX	CAPEX	OPEX	CAPEX	OPEX
Public	£378,000	£22,500	£630,000	£37,500	£949,200	£56,500
Rapids	£0	£0	£0	£0	£165,000	£4,950
Residential – lamppost	£126,080	£25,600	£145,780	£29,600	£185,180	£37,600
Residential – dedicated	£384,000	£25,600	£444,000	£29,600	£564,000	£37,600
Total	£888,080	£73,700	£1,219,780	£96,700	£1,863,380	£136,650

Figure 10 Results of economic analysis of EV strategy – 'Minimum', 'Adequate' & 'Target'



The economic analysis of the proposed EV charging infrastructure strategy allows us to make the following observations:

- The scheme is forecast to result in positive benefits relating to carbon emissions and air quality. These impacts are estimated to represent a monetary value of approximately £7m over a 10-year period.
- The scheme is forecast to result in negative impacts resulting from the costs of implementing the scheme, which range between approximately £1.6m ('Minimum') and £3.1m ('Target').

The results indicate the EV charging infrastructure strategy would result in a **positive Net Present Value** (i.e. the benefits for carbon emissions and air quality would outweigh the costs of implementing the scheme). The NPV can be seen to fall as the number of charging points, and subsequent costs, increase. However, this assumes the uptake of the scheme remains constant regardless of the level of investment in charging points – as explained in the "Derby EV Strategy & Electric Taxis" report, we have assumed differing ratios of chargers to EVs. It should also be noted that the upgrade costs (i.e. the cost of purchasing the EVs) have not been factored into the assessment.

Overall, the implementation of the EV charging infrastructure strategy is forecast to have a positive impact on emissions and represent a positive NPV for the Council. Furthermore, the scheme would provide vital support to the City's broader package of low emission measures, the cumulative impact of which has not been considered in this assessment.

3 Discussion of Results

A targeted approach to emissions reductions on Stafford Street should focus on increasing the proportion of EVs which use the road. The traffic which travels through the link originates from a number of key locations:

1. Traffic from outside of Derby coming to the city for business or leisure, mainly from the west of the city.
2. Traffic from residential areas in Derby, again mainly from the west part of the city.
3. Traffic to and from the city centre
4. Traffic to businesses in Derby.

The recommendations made in "***Derby EV Strategy & Electric Taxis – Final Report"*** were intended to increase the uptake of EVs throughout the city and support the transition to 50% electric taxis by 2025. These recommendations have specific impacts on Stafford Street emissions, as detailed in Table 11.

Table 11 Summary of impacts EV infrastructure recommendations will have on emissions on Stafford Street

Recommendation from "*Derby EV Strategy & Electric Taxis – Final Report"*	Impact on Stafford Street emissions
Increased EV uptake in the city through the full range of additional measures	• Through a combination of all the measures presented in "***Derby EV Strategy & Electric Taxis – Final Report"*** a total of **8,035** are expected to be registered in Derby by 2025. • This is expected to comprise **6.8% of the total vehicle fleet** in the city. • A reduction in NOx, PM_{10} and $PM_{2.5}$ along Stafford Street of **0.026, 0.0031 and 0.0018 tonnes** respectively, would be enabled through this increase in EVs.

Recommendation from “*Derby EV Strategy & Electric Taxis – Final Report”*	Impact on Stafford Street emissions
Installation of public EV chargers in city centre car parks	• Many journeys which pass through Stafford Street have origins or destinations in the city centre. • Charging infrastructure in public car parks in the city centre **will provide charging capability for many trips going through Stafford Street**. • Electrification of up to **10.6%** of the traffic on Stafford Street could be enabled through this measure through enabling more EV usage with the additional public chargers. • This measure targets the high proportion of journeys that originate from outside the Derby City area.
Increased uptake of electric taxis	• 2-2.7% of the traffic on Stafford Street is taxis, which is high when compared with the overall fleet proportion in Derby City. • If 50% of the taxis were electrified, this would account for **1-1.35%** of the traffic on Stafford Street. • This is supported through the installation of rapid chargers for taxis and on-street residential chargers in areas where many taxi drivers live.
Installation of on-street residential chargers	• Many of the on-street residential chargers that have been recommended are in areas with high origin density for trips through Stafford Street. • As most trips originate from home, for these trips to be electrified, residential charging must be in place. However, many of these areas have few off-street parking opportunities. • On-street EV charging provision targeted in these areas may lead to an increase in EV uptake, leading to targeted reductions in emissions on Stafford Street.
Installation of workplace chargers	• A proportion of the traffic on Stafford Street has a destination that appears to be business premises. This implies that many of these journeys are made by commuters. • Installation of workplace charging at these locations would encourage electrification of these journeys.

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