



Visualising transport geography

Geospatial analysis to identify promising car parks for installing electric vehicle charge points: An Oxford case study

Katherine A. Collett^{*}, Sivapriya Mothilal Bhagavathy, Malcolm D. McCulloch

Energy and Power Group, Department of Engineering Science, University of Oxford, UK

ARTICLE INFO

Keywords:

Electric vehicle charging
Public charge points
Geospatial
Car parks
Oxford

ABSTRACT

Historically in the UK, uptake of electric vehicles (EVs) has been dominated by those with off-street parking. In fact, a recent report by Deloitte found that nearly 90% of EV drivers currently charge privately. However, if we wish to meet the UK Government's targets of net zero by 2050 and no further sales of fully internal combustion engine vehicles after 2030, EV charging will need to be made accessible to those without driveways. Local Authorities and the companies they work with have a significant role to play in infrastructure planning to get ahead of the curve of accelerating EV uptake. This Visualising Transport Geography article investigates whether it is possible to identify locations for public EV chargers which may be more valuable to residents.

1. Introduction

This Visualising Transport Geography article investigates whether it is possible to identify locations for public EV chargers which may be more valuable to residents. Historically in the UK, uptake of electric vehicles (EVs) has been dominated by those with off-street parking (Li et al., 2017). In fact, a recent report by Deloitte found that nearly 90% of EV drivers currently charge privately (Deloitte, 2019). However, if we wish to meet the UK Government's targets of net zero by 2050 (UK Government, 2021) and no further sales of fully internal combustion engine vehicles after 2030 (UK Government, 2020), EV charging will need to be made accessible to those without driveways. Local Authorities and the companies they work with have a significant role to play in infrastructure planning to get ahead of the curve of accelerating EV uptake.

To do so, geospatial findings are presented which assess the potential market size for public electric charge points in car parks across Oxford. The analysis is done using GECCO, the Geospatial Evaluator for EV Charging in Car parks Overnight, which is available on GitHub (Geospatial Evaluator for EV Charging in Car parks Overnight (GECCO), 2021). Visualisations of this type can be produced across the UK using this tool, and can inform local authorities, car park operators, and charge point installation companies as to where the greatest demand for public charging may exist.

Fig. 1 shows a case study of Oxford, which recently introduced a zero-emission zone in the centre of the city. The local authority is

encouraging residents to *avoid* motorised transport, *shift* to public transport, and, in the cases where this is not possible, to *improve* their emissions by transitioning to electric.

Oxford car parks in yellow, surrounded by the *pedestrian shed* in pink. The pedestrian shed is roughly 400 m (i.e., a 5-min walk), which is considered the threshold distance pedestrians are prepared to walk before choosing to drive. Houses that are unlikely to have off-street parking within the pedestrian shed are in green. Because on-street electric vehicle charging, such as lamppost charging, may reduce the market size for charge points in a car park, houses on narrow roads, where on-street parking is less likely are displayed in red.

2. Methodology

GECCO is run from the plug-in python console directly in QGIS, where the visualisation is then displayed as the output.

Input data consisted of Ordnance Survey layers of buildings and roads accessed through UK Digimap (UK Digimap, n.d.) as well as data on the locations of car parks from OpenStreetMap, provided by Geofabrik (Geofabrik GmbH and OpenStreetMap Contributors, 2018). Shape files of the UK postal districts from the University of Edinburgh (Pope, 2017) are also used so that analysis is done at the postal district level. In this case, the postcode OX2 was selected.

Firstly, buildings are filtered to those which have a footprint area between 17 m² and 250 m². These are shown as houses in the visualisation. This is to exclude buildings which are unlikely to be residential

^{*} Corresponding author.

E-mail address: katherine.collett@eng.ox.ac.uk (K.A. Collett).

<https://doi.org/10.1016/j.jtrangeo.2022.103354>

Received 17 December 2021; Received in revised form 21 April 2022; Accepted 30 April 2022

Available online 13 May 2022

0966-6923/© 2022 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

(e.g., sheds, schools, hospitals). Roads are filtered to only consider “road or track”, thus excluding paths. The width of the road is calculated using data on the perimeter and the area, and assuming the feature is a uniform rectangle. This results in a quadratic equation, which is solved, and the lowest value taken.

The car parks in the given postcode district are mapped (excluding any which are specifically tagged as “private” or “no access”) and each remaining car park is assigned a variable locus to define the “area of interest”. In this example, the area of interest is set to 400 m radius, previously explained to be the distance commonly used as the pedestrian shed. Houses are filtered to within the area of interest.

In order to filter out houses which are likely to have off-street parking, two criteria are tested. Firstly, does a house have a distance of more than 5 m between itself and the nearest house? This is to filter out detached houses, which are assumed to have private off-street

parking. Secondly, is the distance between the house and the road greater than 7 m, including the width of the pavement? This distance was set to assess whether there would be space for a driveway between the house and the pavement. It is calculated to allow for the length of a car (5 m) and the width of the pavement (2 m). Both of these distances are variable in GECCO. If either of these criteria are met the house is assumed to have off-street parking and removed for the analysis.

Finally, in many instances it will be useful to understand if a road is wide enough to comfortably accommodate on-street parking. If a local authority has plans to implement on-street charging, for example lamppost chargers, then EV chargers in a nearby car park may have greater competition in that area. So that this can be considered in any planning, houses where the nearest road is of a width less than 5 m are highlighted in a different colour. A road of width below 5 m was assumed to be able to offer limited on-street parking given that cars have

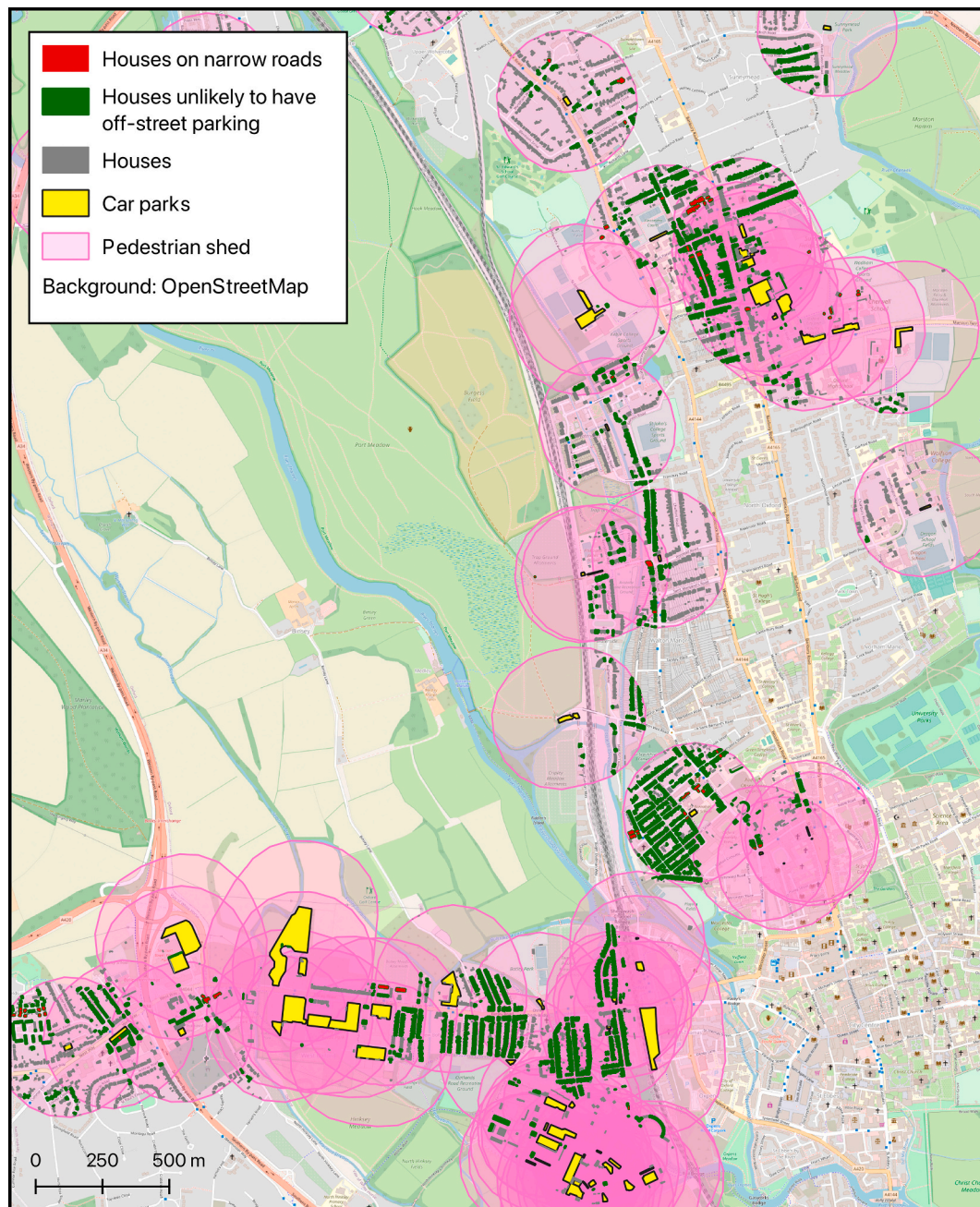


Fig. 1. Geospatial visualisation of Oxford (OX2) car parks to evaluate suitability for electric vehicle charge point installation.

a width of ~2 m. All of these filtering parameters can be modified within GECCO.

3. Results

The results show that in the pedestrian shed surrounding different car parks, the number of houses which are unlikely to have off-street parking, and thus rely on public EV charging, varies significantly. For example, the car park east-most on the map has a very low density of houses without off-street parking. However, there is not a clear pattern. Some car parks situated in residential areas are surrounded by houses without off-street parking, whereas others are not. The apparent lack of a simple pattern highlights the importance of a tool such as this in identifying promising car parks for situating EV charging points.

Another useful aspect of this visualisation is that it shows houses where the pedestrian sheds from different car parks overlap, i.e., where residents have access to more than one car park nearby. These residents may have more options as to where they park and charge, and therefore competition between charge point operators may need to be considered in decision making.

4. Conclusions

As EV adoption continues to increase, the demand for charging options for those without off-street parking will also rise. Introducing EV charge points to local car parks within walking distance of residential houses is one promising option within the portfolio of charging offerings that will be necessary. However, selecting the most promising car parks is not trivial. In this article we propose that it is possible to identify car park locations where EV chargers will be more valuable to residents' overnight charging needs. To do so, the number of houses without off-street parking within the pedestrian shed of a car park is considered, along with the likelihood of competition from on-street charging and other potential car parks with EV charging. Using these results, local authorities, car park operators, and charge point operators can identify valuable sites for EV charging points.

CRedit authorship contribution statement

Katherine A. Collett: Methodology, Software, Investigation, Validation, Writing – original draft, Writing – review & editing. **Sivapriya Mothilal Bhagavathy:** Conceptualization, Methodology, Software, Funding acquisition. **Malcolm D. McCulloch:** Conceptualization, Supervision, Funding acquisition.

Declaration of Competing Interest

None.

Acknowledgments

The authors acknowledge Innovate UK grant funding, reference number 105428. They thank Hannah Budnitz and all project partners for their ongoing support.

References

- Deloitte, 2019. Hurry Up and... Wait: The Opportunities Around Electric Vehicle Charge Points in the UK. <https://www2.deloitte.com/content/dam/Deloitte/uk/Documents/energy-resources/deloitte-uk-Electric-Vehicles-uk.pdf>.
- Geofabrik GmbH and OpenStreetMap Contributors, 2018. Great Britain [Online]. Available. <http://download.geofabrik.de/europe/great-britain.html>.
- Geospatial Evaluator for EV Charging in Car parks Overnight (GECCO) [Online]. Available. <https://github.com/EPGOxford/GECCO>.
- Li, W., Long, R., Chen, H., Geng, J., 2017. A review of factors influencing consumer intentions to adopt battery electric vehicles. *Renew. Sust. Energ. Rev.* 78, 318–328.
- Pope, A., 2017. GB Postcode Area, Sector, District, [Dataset]. University of Edinburgh. <https://doi.org/10.7488/ds/1947> [Online]. Available.
- UK Digimap [Online]. Available. <https://digimap.edina.ac.uk>.
- UK Government, 2020. Government Takes Historic Step Towards Net-Zero with End of Sale of New Petrol and Diesel Cars by 2030 [Online]. Available: <https://www.gov.uk/government/news/government-takes-historic-step-towards-net-zero-with-end-of-sale-of-new-petrol-and-diesel-cars-by-2030>.
- UK Government, 2021. UK's Path to Net Zero Set Out in Landmark Strategy [Online]. Available: <https://www.gov.uk/government/news/uk-path-to-net-zero-set-out-in-landmark-strategy>.