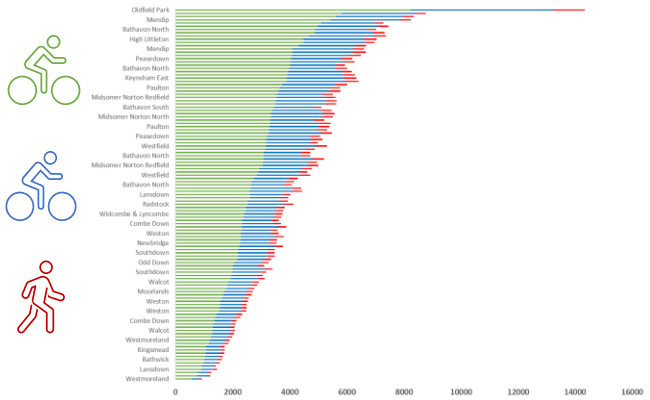
Appendix D: What is the potential for e-bikes to reduce car use, carbon emissions and car dependency in Bath and North East Somerset? And in relation to West of England Combined Authority areas?



Analysis by Pete Dyson (Doctoral Researcher at University of Bath and Bicycle Mayor of Bath) involving re-running a national transport model published by Ian Philips et al., (2022)(University of Leeds) specifically for the Bath and West of England Combined Authority Area

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UNIVERSITY OF BATH

UNIVERSITY OF LEEDS
Institute for Transport Studies

Executive Summary

Past research at a national level estimates electrically assisted pedal bikes (e-bikes) could significantly **reduce car usage and address vulnerability to high transport costs** (Philips et al., 2022).

This mini-project has re-run this national model specifically for the BathNES region, which covers 115 LSOA areas (roughly 400-1000 households in each) and compared this with the West of England Combined Authority region (WECA). This high-resolution data takes into account **people's current travel behaviour, car ownership, health/fitness and the hilliness of roads in the neighbourhood**. (It does not account for quality of local infrastructure, like the current quality of roads for cycling and walking, which is a limitation).

This new model estimates the walking, bike and e-bike potential for each area, intentionally making an **upper bound estimate for what is technically possible, rather than a forecast or recommendation.**

This information can guide where to invest improvements in cycling and walking infrastructure to (a) reduce car usage (b) reduce carbon emissions (c) improve equity and equality

This new BathNES data show that e-bikes could potentially replace a large amount of car travel (roughly 2,500km per person per year). The contribution is a much larger in countryside and rural areas because (a) car ownership and usage is much higher in these places, so there is more to replace (b) e-bikes have the biggest relative advantage at covering longer distances than people need to cycle in cities (c) e-bikes create cycling capability in hilly areas.

For BathNES, the potential contribution of e-bikes is approximately **double** that of traditional bikes and **ten times** that of walking to reduce car distance travelled.

The vulnerability index makes an important contribution, showing how specific places of socioeconomic deprivation and car dependency could benefit most from e-bikes to address inequalities other than carbon and car use reduction.

This report and data could be useful for:

Bath & North East Somerset Council
Improving People's Lives

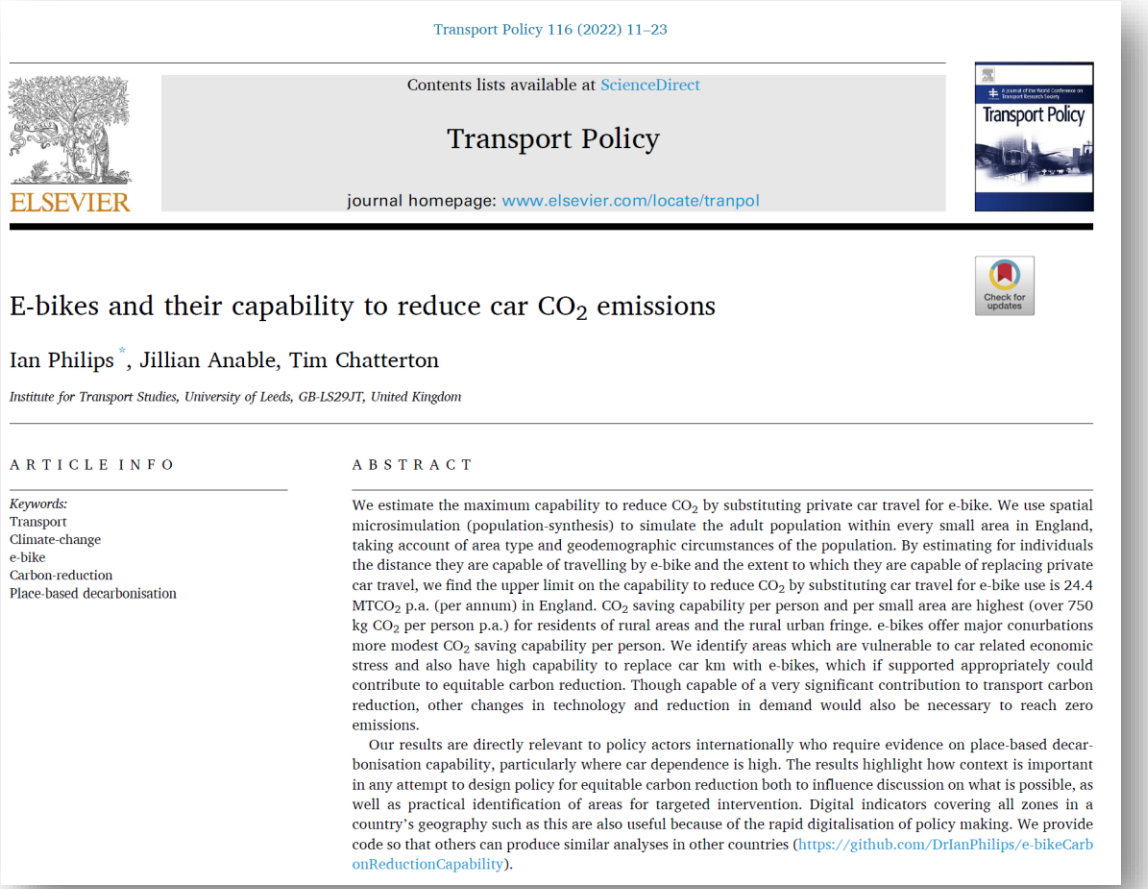
Transport Modelling
Local Transport Plans
Active Travel Scheme Planning
Net Zero and Just Transition

1. Background: why e-bikes and why now?

University of Leeds Researchers from the Centre for Research into Energy Demand Solutions (CREDS) found that e-bikes, if used to replace car travel, have the capability to cut car carbon dioxide (CO2) emissions in England by up to 50% – about 30 million tonnes per year.

Even replacing just 20% of car miles travelled with e-bike travel would mean 4-8 million fewer tonnes of carbon emitted each year.

The greatest impact on carbon emissions would come from e-bike use outside urban centres. In Denmark, e-bike routes are already linking cities to towns and villages.



Transport Policy 116 (2022) 11–23

Contents lists available at ScienceDirect

Transport Policy

journal homepage: www.elsevier.com/locate/tranpol

E-bikes and their capability to reduce car CO_2 emissions

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ARTICLE INFO

Keywords:
Transport
Climate-change
e-bike
Carbon-reduction
Place-based decarbonisation

ABSTRACT

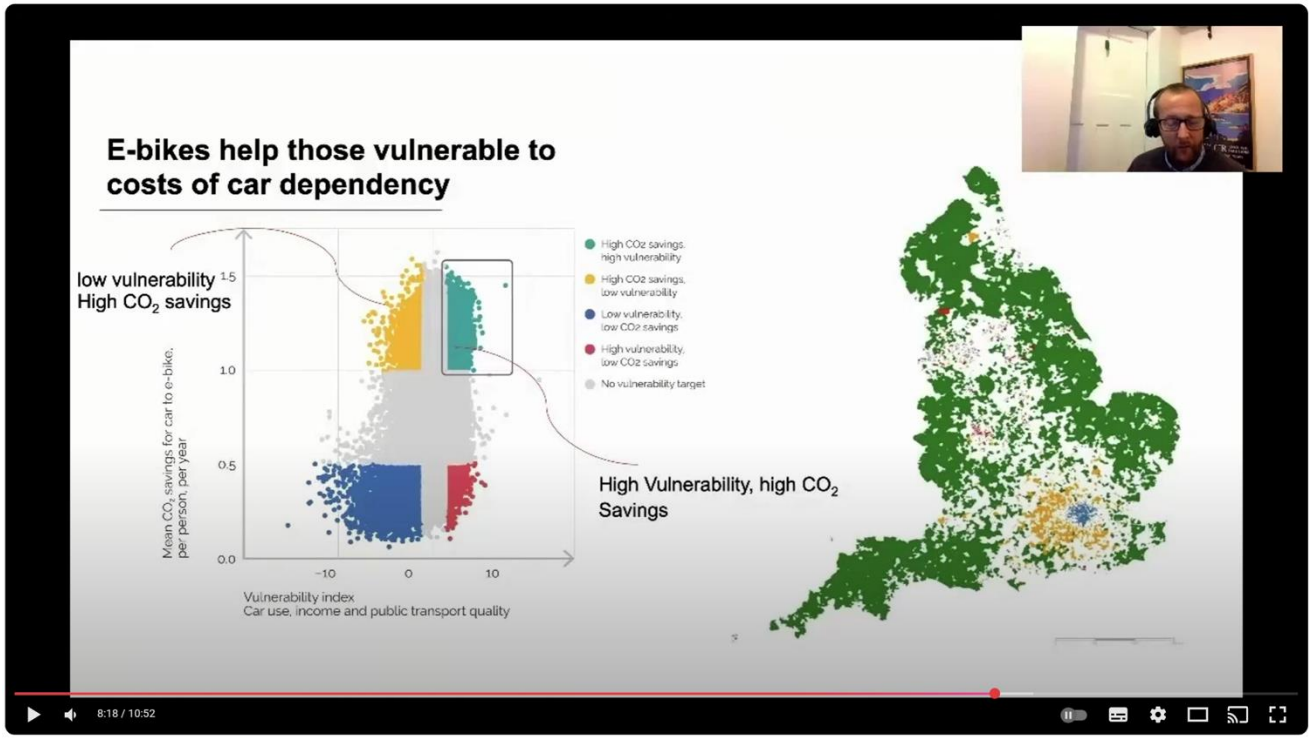
We estimate the maximum capability to reduce CO_2 by substituting private car travel for e-bike. We use spatial microsimulation (population-synthesis) to simulate the adult population within every small area in England, taking account of area type and geodemographic circumstances of the population. By estimating for individuals the distance they are capable of travelling by e-bike and the extent to which they are capable of replacing private car travel, we find the upper limit on the capability to reduce CO_2 by substituting car travel for e-bike use is 24.4 $MTCO_2$ p.a. (per annum) in England. CO_2 saving capability per person and per small area are highest (over 750 kg CO_2 per person p.a.) for residents of rural areas and the rural urban fringe. e-bikes offer major conurbations more modest CO_2 saving capability per person. We identify areas which are vulnerable to car related economic stress and also have high capability to replace car km with e-bikes, which if supported appropriately could contribute to equitable carbon reduction. Though capable of a very significant contribution to transport carbon reduction, other changes in technology and reduction in demand would also be necessary to reach zero emissions.

Our results are directly relevant to policy actors internationally who require evidence on place-based decarbonisation capability, particularly where car dependence is high. The results highlight how context is important in any attempt to design policy for equitable carbon reduction both to influence discussion on what is possible, as well as practical identification of areas for targeted intervention. Digital indicators covering all zones in a country's geography such as this are also useful because of the rapid digitalisation of policy making. We provide code so that others can produce similar analyses in other countries (https://github.com/DrIanPhilips/e-bikeCarbonReductionCapability).

Philips, I., Anable, J., & Chatterton, T. (2022). E-bikes and their capability to reduce car CO2 emissions. *Transport Policy*, *116*, 11-23.

https://www.sciencedirect.com/science/article/pii/S0967070X21003401

2. Context: a 10minute video explaining the context and findings



Prof. Jillian Anable and Dr Ian Philips, The University of Leeds - Research Panel

https://www.youtube.com/watch?v=NvL2UKbCDtU&t=214s&pp=ygUTaWFuIHBoaWxpcHMgZSBiaWtlcw%3D%3D

3. Inputs: what has gone into the model?

The national e-bike potential model estimates the upper limit on the capability to travel by e-bike and replace car travel, and from that the maximum capability to reduce CO2 emissions. We used spatial microsimulation (also known as population synthesis) to generate a synthetic population of individuals.

This method links small area census data to anonymous individual survey data to simulate a population of individuals for every small area in the study area. Once generated, the attributes of synthetic individuals are used to estimate the capability of individuals to travel by e-bikes to reduce car use, taking account of the distribution of car distances travelled in those areas, but also the fact that some people in an Lower Super Output Area (LSOA) are fitter than their neighbours, so can ride further.

Key factors used in the model:
Hilliness + population health + existing travel demand + car usage + socioeconomic status + walk/cycling/e-bike potential

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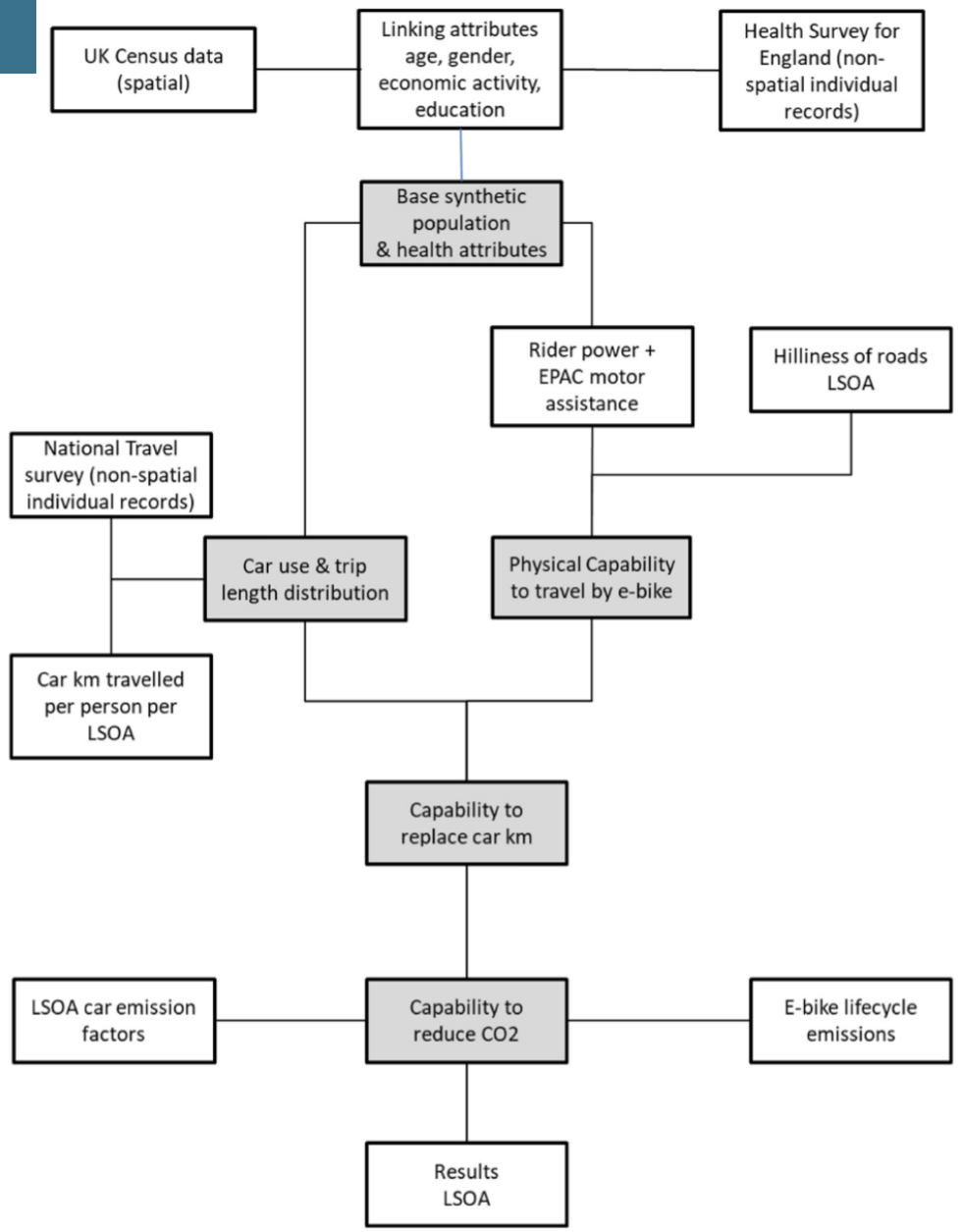


Fig. 1. Spatial microsimulation model overview. The main steps in the process of estimating e-bike CO_2 reduction capability are shown in grey and are described in subsections in the text. Data sources feeding each step are also shown.

4. What has the national research output show?

1) Nationally, e-bikes have large potential to get people cycling in a way that classic-bikes do not. Roughly double the potential.
2) The biggest car use reduction potential would come from outer urban and rural areas (where not many people live, but where people produce a large amount of car mileage, emissions and least public transport availability)
3) That areas most ‘vulnerable’ (with high car use, low income and transport quality) can be identified in the data and could be targeted for support (either in infrastructure improvements, or direct to places/households)

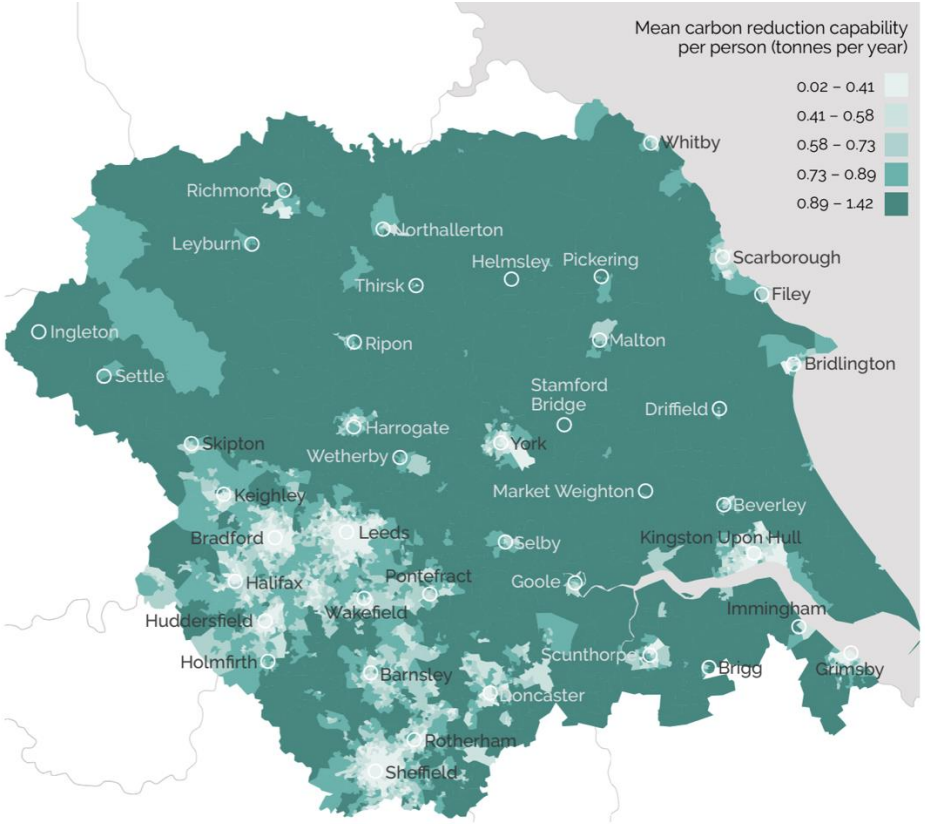


Figure 1: e-bike carbon reduction capability for rural areas (e.g. North Yorkshire) is higher than in large cities (e.g. Leeds)

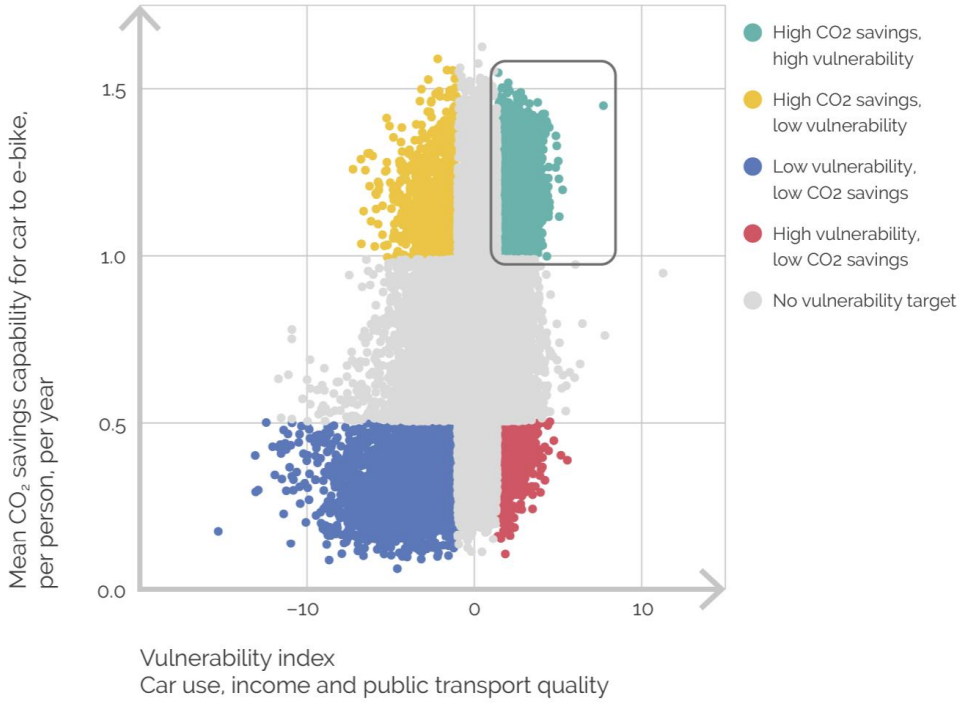
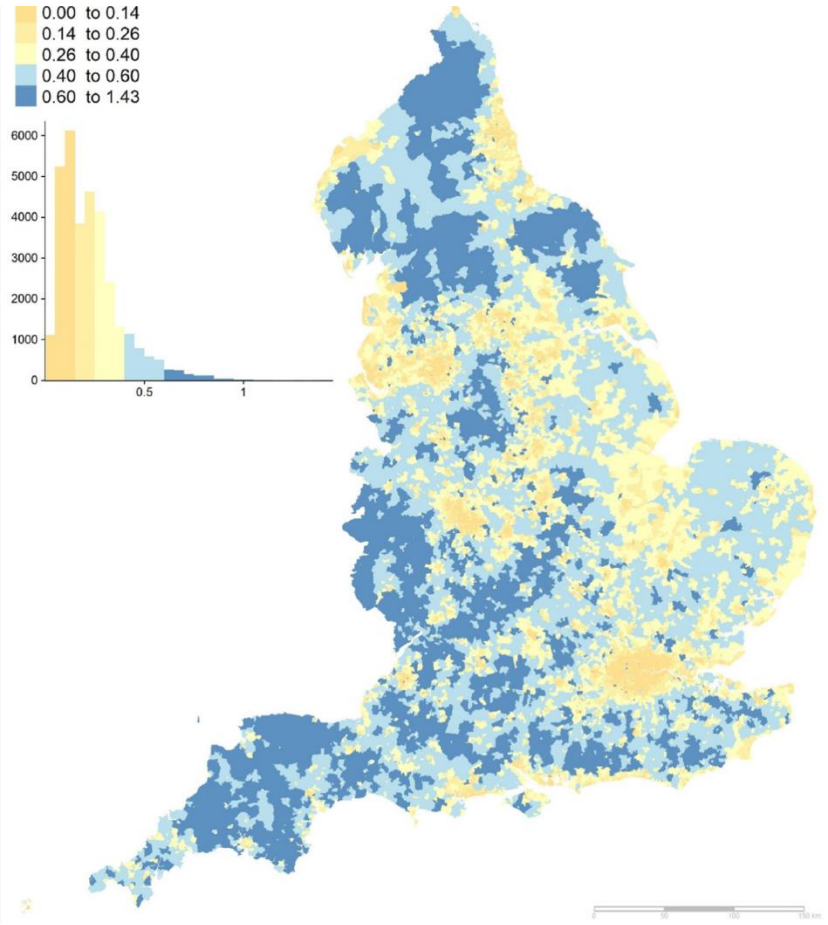


Figure 2: Relationship between capability to reduce car CO_2 using e-bikes and vulnerability to motor fuel price increases.

5. Running the model for Bath & North East Somerset

The Census divides England into 33,000 Lower Super Output Areas (LSOA).
Each one has between 400-1000 household.

Bath & North East Somerset Council



- The original study covered the whole of England, giving results for each of the 33,000 LSOAs. BathNES has 115 LSOAs
- The method of this mini-project has been simple, download the data and filter to analyse only BathNES regions.
- Results are available for both car distance (km) reduction per person and for CO2e reduction. Only the latter is shown because the figures are perfectly correlated, and car use reduction in kilometres is considered easier to understand than tonnes CO2e, while being more relevant for other co-benefits (like congestion)
- The data is freely and publicly available here for other regions, it only requires a simple excel file to open, filter and explore:

https://github.com/DrIanPhilips/e-bikeCarbonReductionCapability/blob/master/results/copy_e_bike_carbon_reduction_capability_results.csv

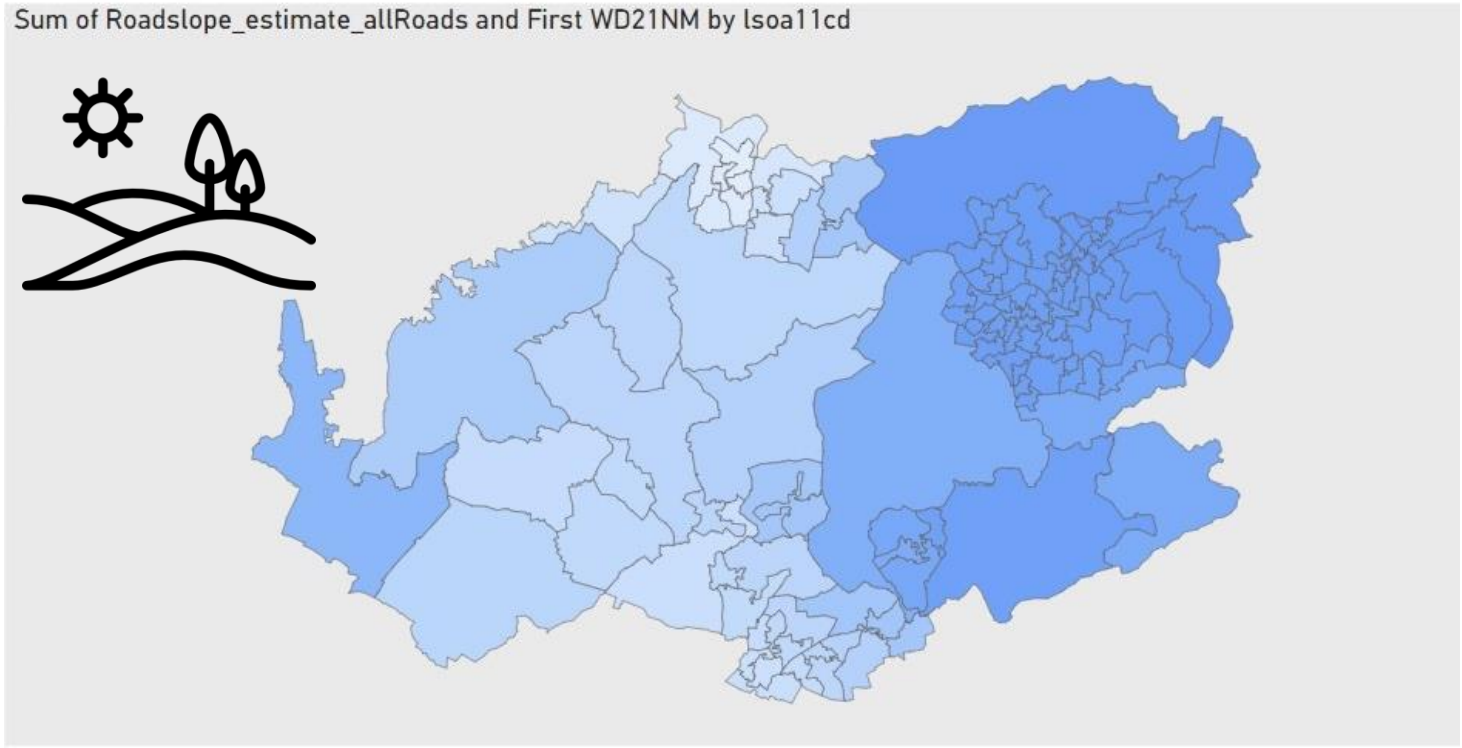
6. Just how hilly is Bath & North East Somerset?

BathNES is the 26th hilliest local authority region out of 328 in the UK. Roughly similar to Lewes, Bradford and slightly less hilly than Stroud and Sheffield.

This table shows BathNES compared to selected other local authorities, chosen for being nearby places and/or high participation in cycling

Ranking (most hilly)	Local Authorities (n=328)
1	West Somerset
11	Plymouth
16	Stroud
17	Sheffield
23	Bradford
25	Brighton and Hove
26	**Bath and North East Somerset**
31	Lewes
76	Mendip
77	South Somerset
78	Bristol
221	Oxford
237	City of London
314	Cambridge
320	York
328	Fenland

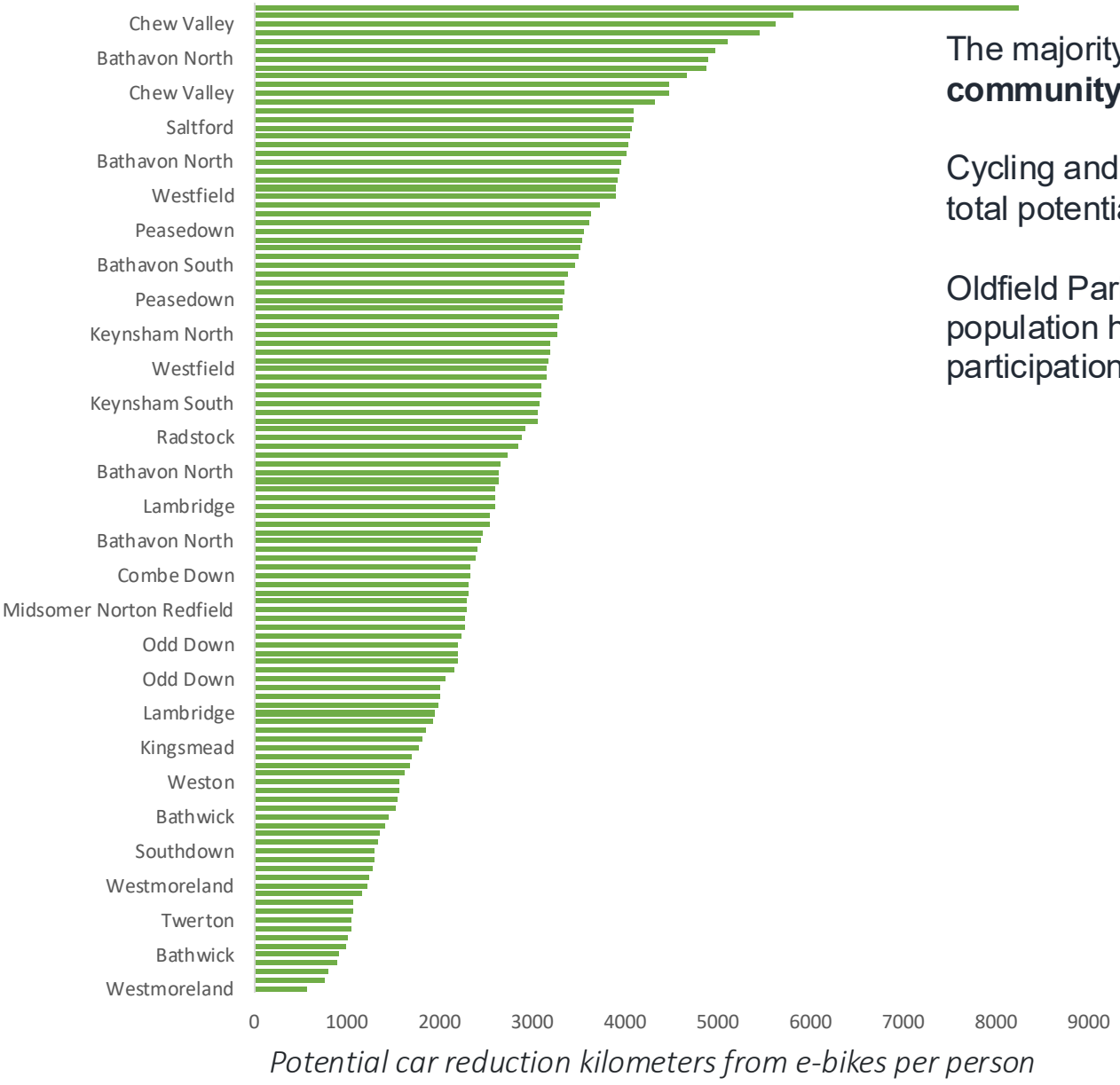
Analysis of road slope data shows the BathNES relative to 326 local authorities.



SRTM digital elevation model: NASA https://www2.jpl.nasa.gov/srtm/cbandda taproducts.html
Roads dataset linked to SRTM to extract the slope of each road: Ordnance Survey Meridian 2 data https://digimap.edina.ac.uk/

Bath's hilliness is mostly in the city region and to the south. Keynsham and Saltford are distinctly flatter

7. For BathNES car use reduction, e-bikes have much bigger impact potential in more rural areas

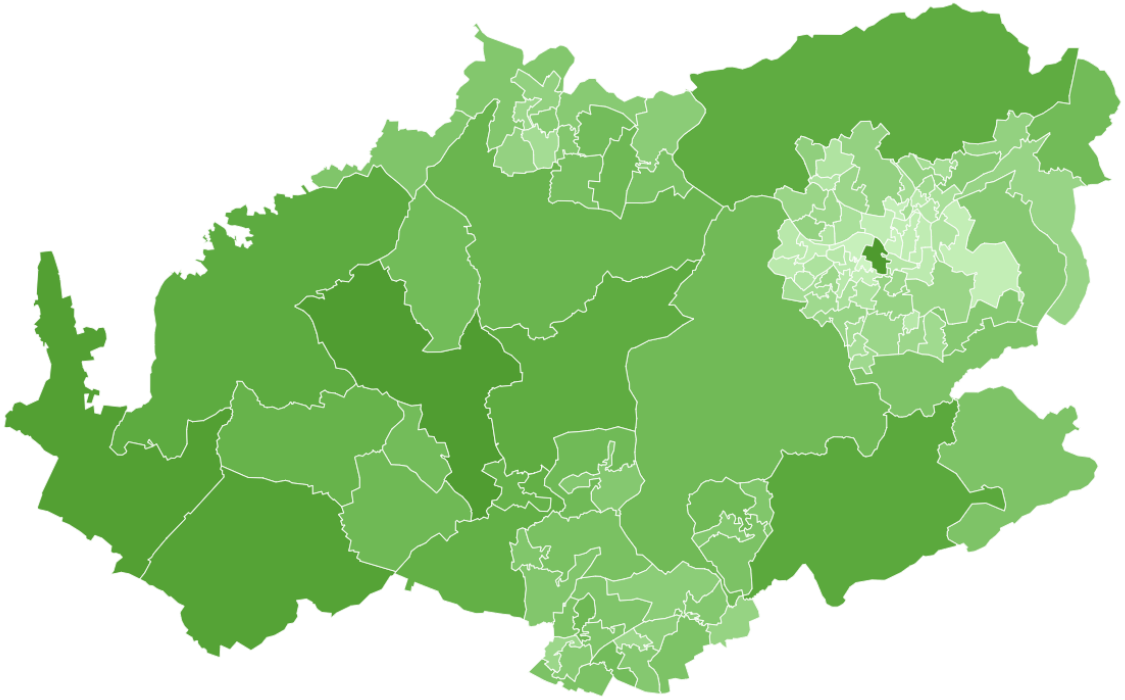


Potential car reduction kilometers from e-bikes per person

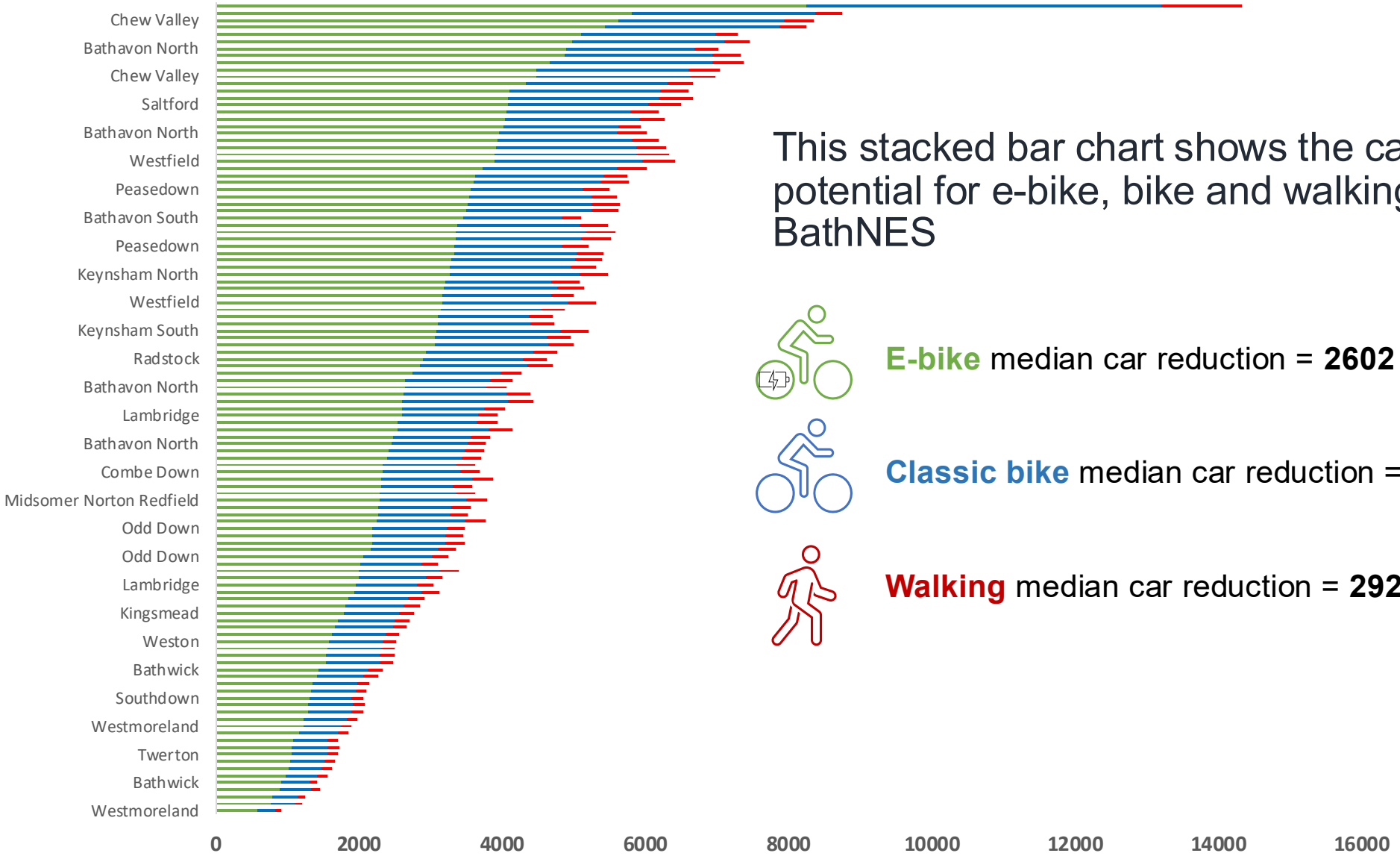
The majority of savings come from **countryside, suburban and industrious community areas** ('OAC supergroup')

Cycling and e-bikes by people living in **Bath city regions cover 35%** of the total potential reduction potential savings for the region overall.

Oldfield Park is an exception and outlier, potentially because the high student population has skewed the data by (a) lack of participation in census (b) participation in census but very low car ownership.



8. For BathNES, e-bikes have approximately twice classic-bikes and ten times walking for car use reduction capability



This stacked bar chart shows the car usage reduction potential for e-bike, bike and walking for each LSOA in BathNES

E-bike median car reduction = **2602 km** *per person per year*

Classic bike median car reduction = **1237 km** *per person per year*

Walking median car reduction = **292 km** *per person per year*

Note: only 35 of 115 LSOAs shown, to retain readable font size

9. Which types places gain the most from e-bikes, cycling and walking?

The relative contribution of e-bikes, bikes and walking is not equal across all places. To illustrate this, we run the analysis and pick out the top 10 and bottom 10 places (out of 115 places in total) to show the differences

Places where **e-bikes make the biggest impact**, when compared to that area's potential bike impact

	KM
Chew Valley	5619
Oldfield Park	8250
Chew Valley	5815
Bathavon **South**	5103
Bathavon North	4900
Mendip	5448
Chew Valley	4973
Clutton & Farmborough	4881
High Littleton	4671
Bathavon **South**	4016

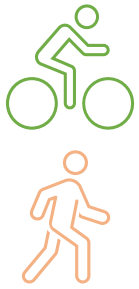
Places where **walking makes the biggest impact**, when compared to that area's potential bike impact

	KM
Widcombe & Lyncombe	210
Bathwick	149
Kingsmead	148
Lansdown	154
Kingsmead	157
Lansdown	131
Westmoreland	106
Kingsmead	102
Westmoreland	76
Oldfield Park	128

Places where **e-bikes make the smallest impact**, when compared to that area's potential bike impact

Kingsmead	1040
Kingsmead	1060
Bathwick	1014
Twerton	1055
Oldfield Park	983
Bathwick	924
Lansdown	900
Westmoreland	791
Kingsmead	761
Westmoreland	579

Places where **walking makes the smallest impact**, when compared to that area's potential bike impact*



Saltford	369
Bathavon South	301
Mendip	394
Bathavon North	332
Chew Valley	413
Chew Valley	360
Bathavon South	311
Chew Valley	352
Mendip	378
Chew Valley	382

** note, these places still have good walking potential, they just also have even better bike potential too*

10. Introducing priority areas with ‘vulnerability to transport cost’

Prior research by Guilio Mattioli et al. (2019) from University of Leeds constructed a spatial indicator of vulnerability to transport cost in England. The indicator of vulnerability considered **car use, cost of motoring fuel, income and accessibility by public transport.**

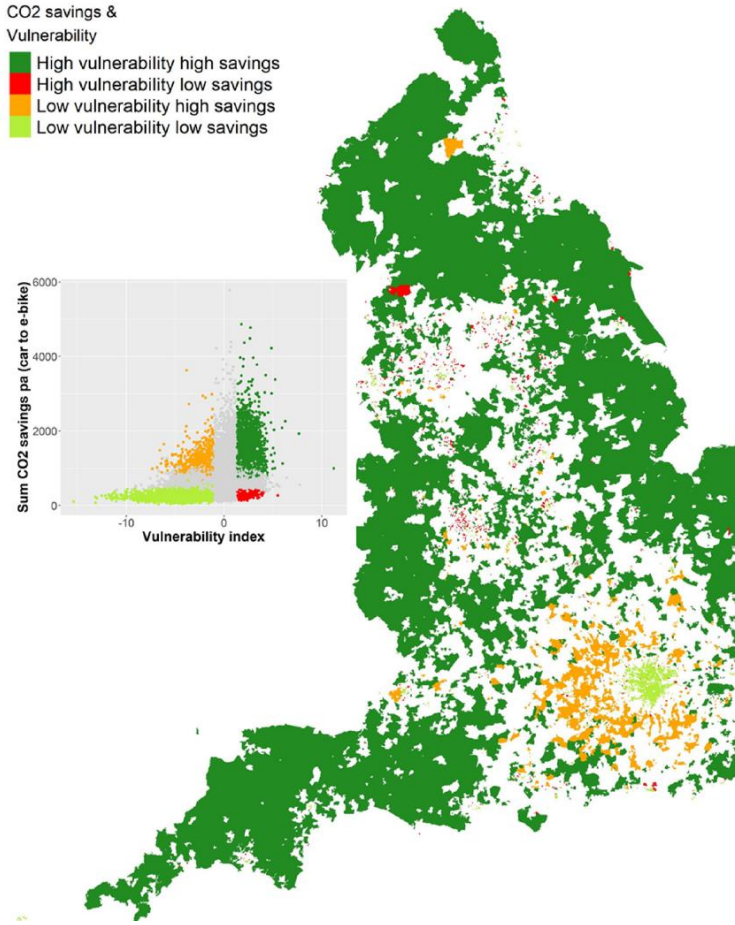
This research looked at how replacing car trips with e-bike trips would reduce total travel cost including the reduction in fuel costs. There could also be savings associated with maintenance, tax, insurance and depreciation if a car could be replaced with an e-bike.

By combining the two datasets, the researcher’s identified ‘high priority’ areas

High priority: LSOAs which have both high vulnerability to transport cost increases and are in the highest quartile of CO2 reduction capability. Income in these LSOAs is slightly lower than the national average, but car km travelled per person is double the national average – being in areas furthest from cities and having poor public transport accessibility.

The researchers identified roughly 3400 LSOAs (out of 33,000 nationally) that may be usefully targeted by policy makers wishing to promote e-bikes to both reduce CO2 emissions and reduce economic stresses of car dependence.

BathNES contains 10 of these priority LSOA (out of 115 LSOAs in the region overall).



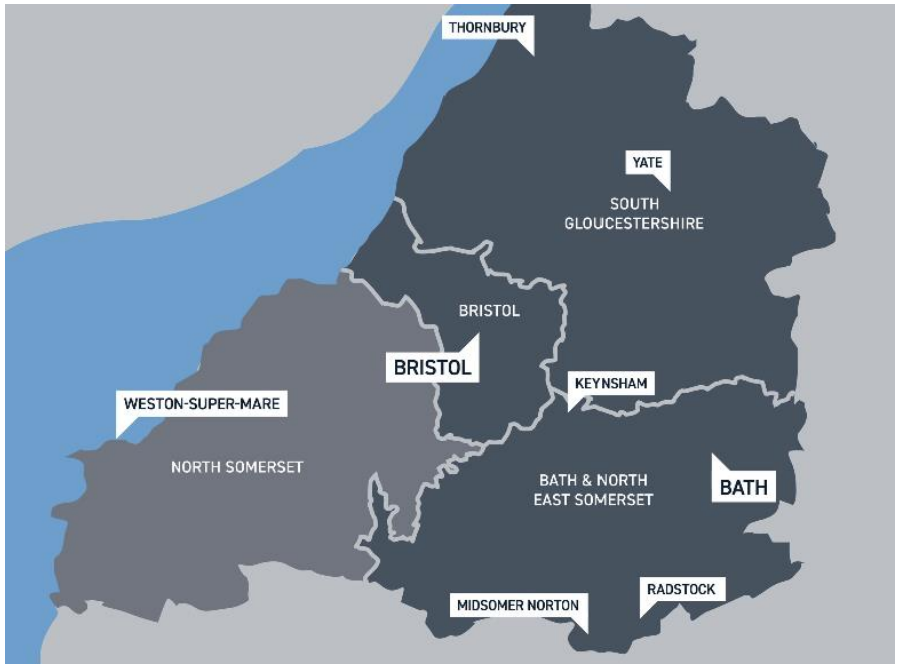
National level vulnerability

11. Bath & North East Somerset : priority areas for vulnerability

Identified as high/low priority	BathNES : LSOA area	OAC Supergroup	Vulnerability Index
High vulnerability, high CO2 savings	**Clutton & Farmborough**	Suburban living	2.5
	Radstock	Industrious communities	2.0
	Paulton	Suburban living	1.9
	High Littleton		1.8
	Mendip		1.7
	Chew Valley	Countryside living	1.6
	Timsbury		1.5
	Clutton & Farmborough		1.4
High vulnerability, low CO2 savings	**Twerton**	Hard-pressed communities	1.6
	Combe Down		1.5
	Bathwick		-1.3
	Walcot		-1.5
	Widcombe & Lyncombe		-1.5
And for reference, they show a category for particularly **low vulnerability, low CO2 savings** areas	**Westmoreland**	Cosmopolitan student neighbourhoods	-1.6
	Southdown		-1.8
	Bathwick		-1.9
	Lansdown		-2.0
	Westmoreland		-3.0
	Lansdown		-3.5

BathNES in context of

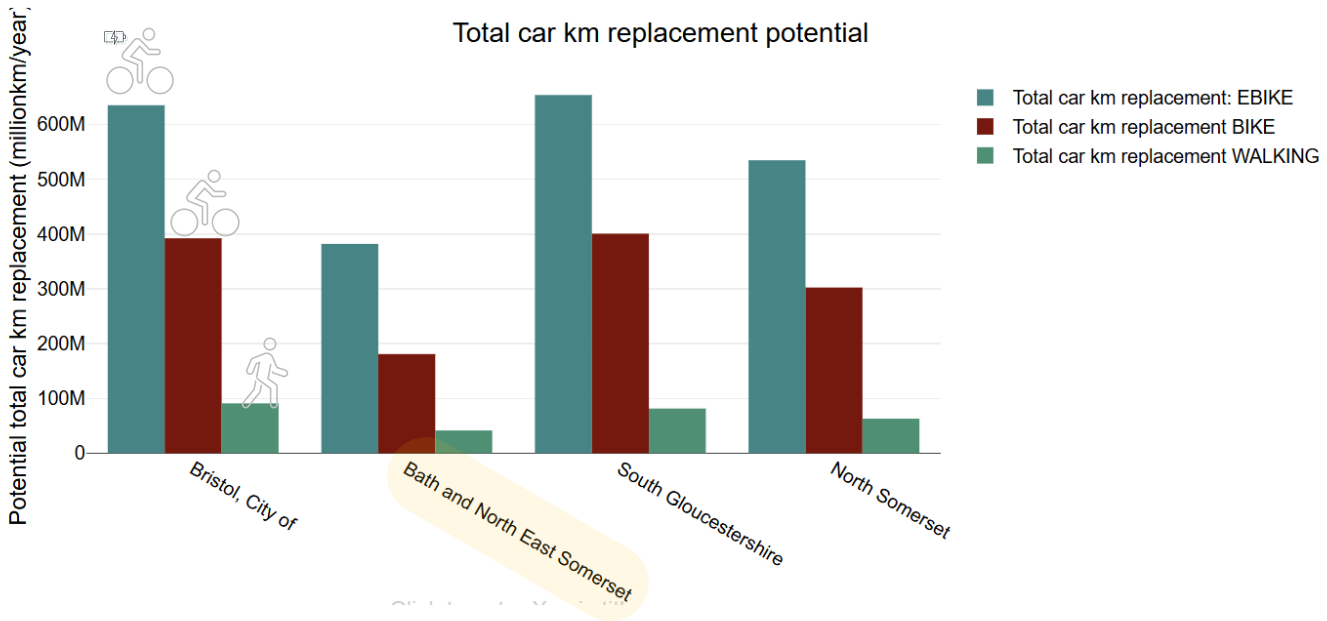
WEST OF ENGLAND Combined Authority



Four local authority regions, 678 LSOAs:

- **Bath and North East Somerset (115)**
- **Bristol City (263)**
- **North Somerset (135)**
- **South Gloucestershire (165)**

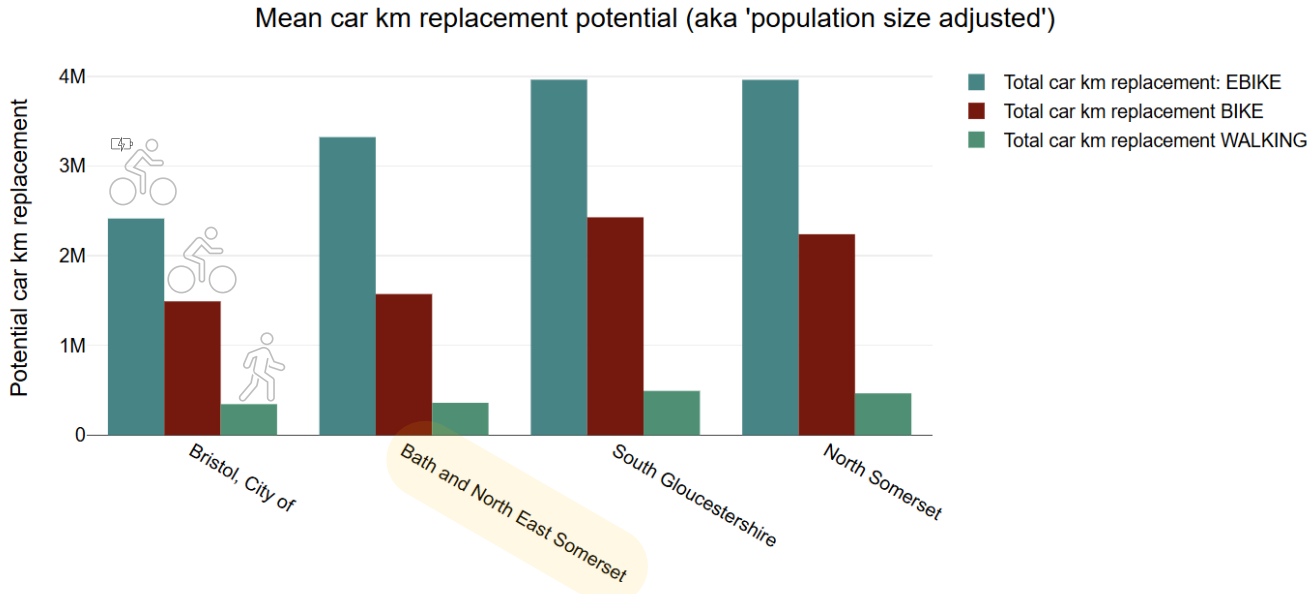
12. Which WECA area stands to gain most from e-bikes?



In total, when considering all four local authorities, **BathNES could contribute 17% of WECAs potential car km reduction** capacity by **e-bike**.

The figure is lower for **classic-bike**, 14%, showing that **BathNES stands to gain more from e-bikes than the other authorities**.

For **walking**, BathNES could contribute 15% of all the car km reductions for walking in WECA overall.



Once adjusted for the **population** size of each local authority, this chart shows that per LSOA, **Bristol is the least 'efficient' at reducing car km by bike and e-bike**. This is because it is very urban and residential car ownership is already much lower than BathNES, SG and NS.

13. For WECA overall, the ‘types’ areas benefitting most from e-bikes are ‘countryside living’ ‘industrious communities’ and ‘suburban living’.

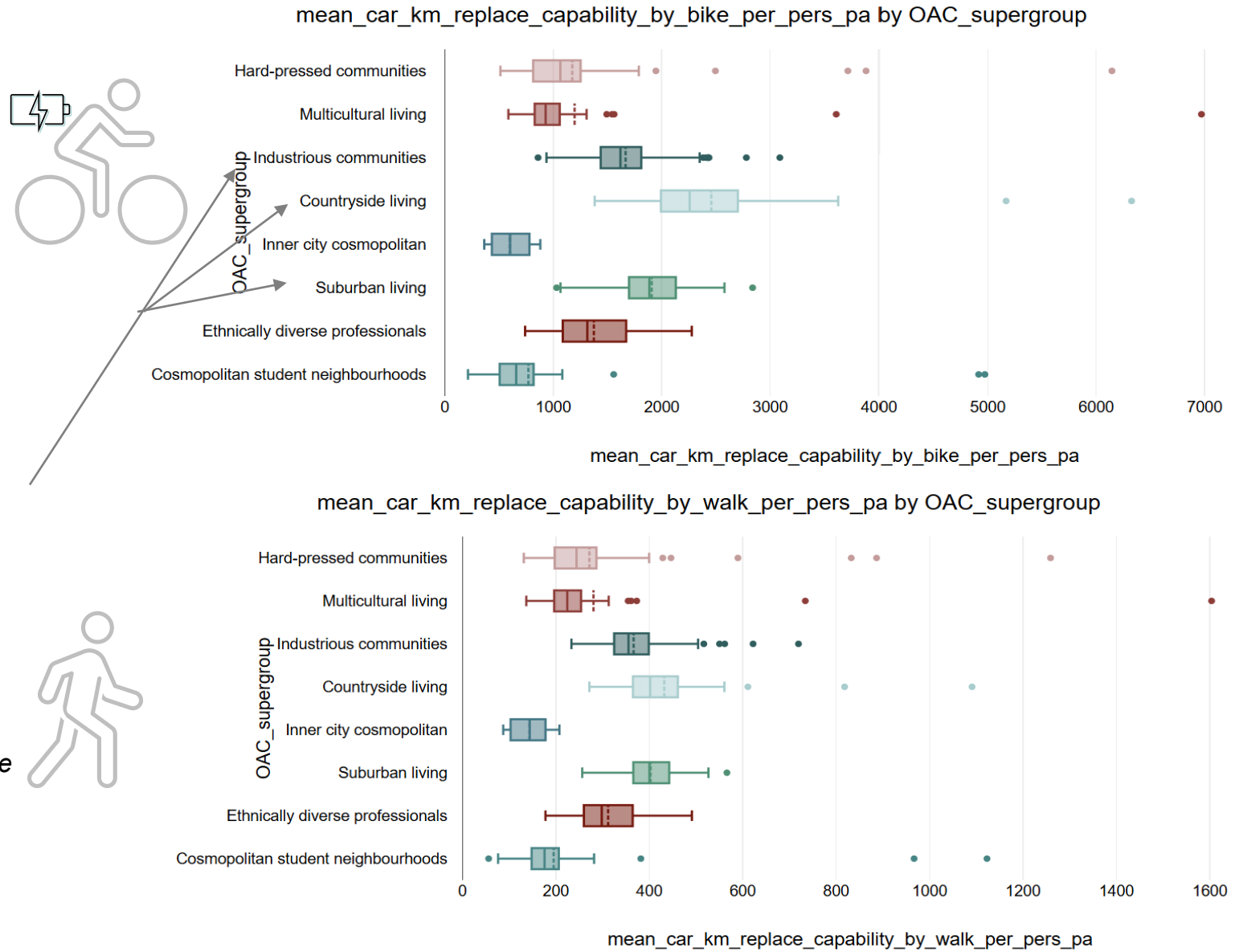
Each LSOA region in WECA (irrespective of council type) is classified into one of 8 ‘types’ of LSOA. Each type refers to a level of urbanity/rurality, ethnicity, demographic and socioeconomic level

This is wider analysis for all 678 LSOAs in WECA region, showing the potential contribution to car km reduction by bicycle and walking for the 8 different types of LSOAs

The top three types of area benefitting most from e-bikes are ‘**countryside living**’ ‘**industrious communities**’ and ‘**suburban living**’. The pattern is similar for walking.

These results may help guide policy direction, investment and targeting.

Outlier LSOAs are shown in dots, demonstrating there is some variability within each category



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Past research at a national level has estimate electrically assisted pedal bikes (e-bikes) could significantly **reduce car usage and address vulnerability to high transport costs.**

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