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Spatial aspects of EV charging

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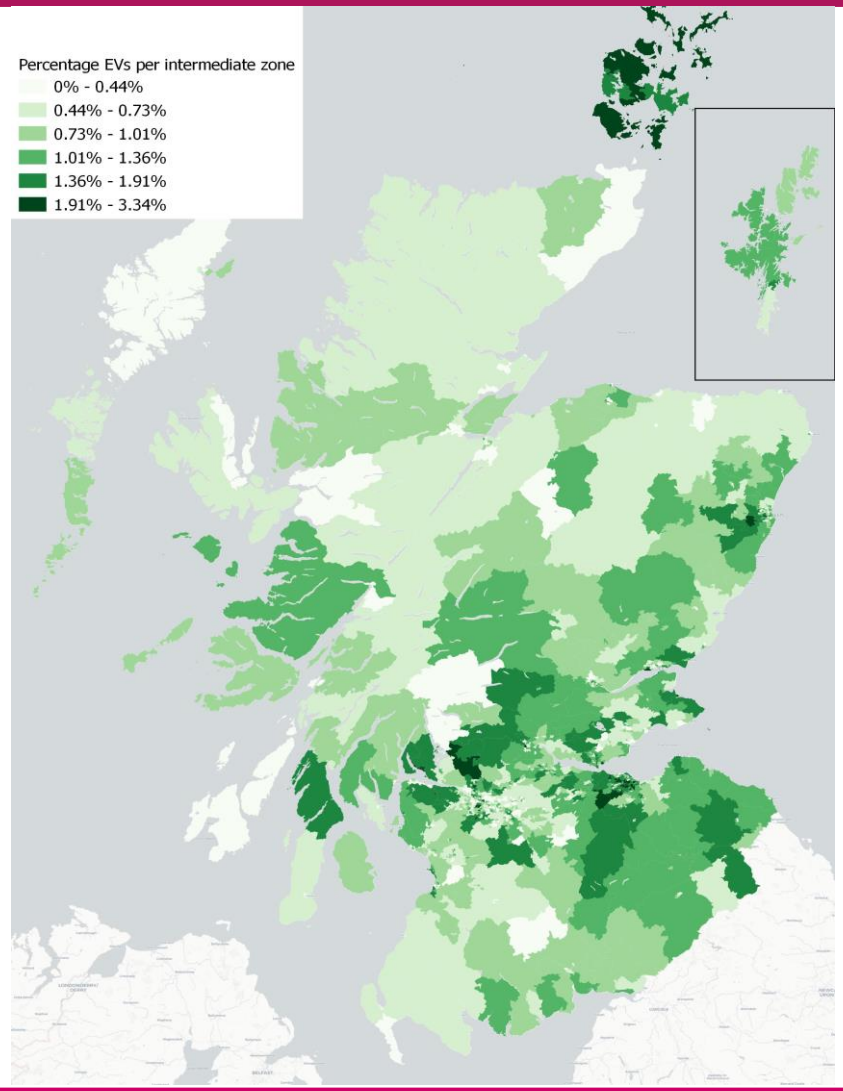

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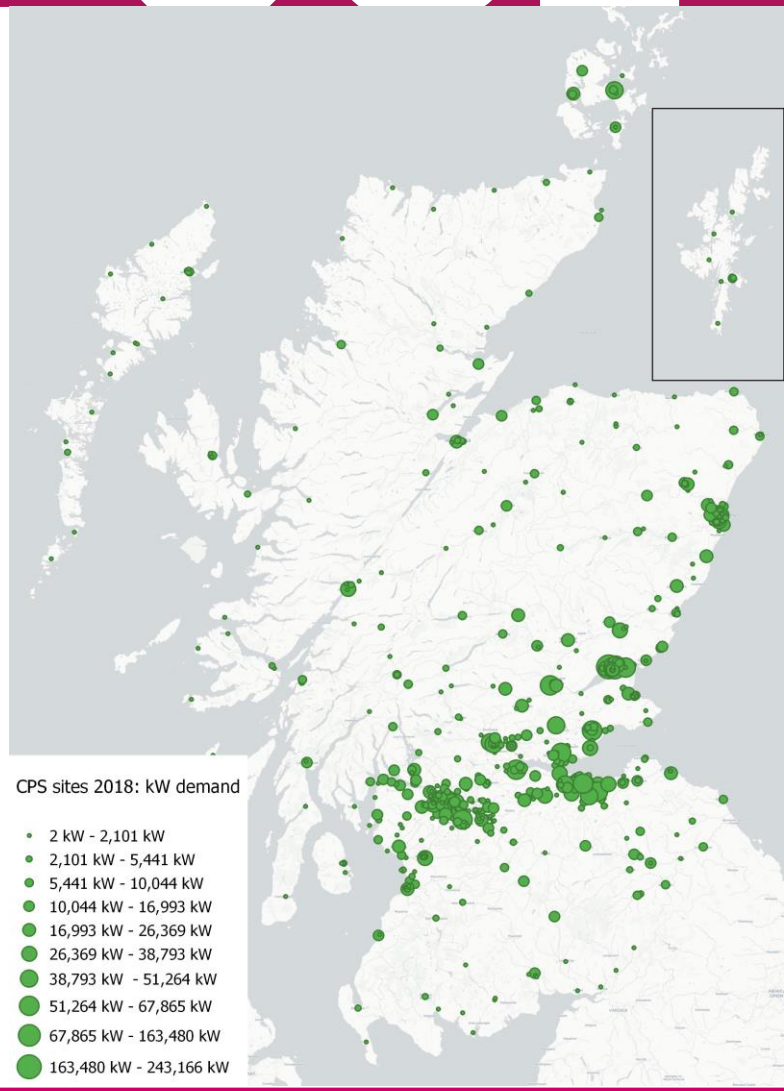
ChargePlace Scotland (CPS)

- Owned by the Scottish government, funded in partnership through from Local Authorities and other organisations
- Aims to make owning an EV accessible for all Scottish drivers by installing public charge points across the country
- Manages a network of 2,500 charge points in 2021 (up from 55 in 2013)
- These charge points can be divided in slow, fast and rapid charge points
- Scotland has one of the highest charge points to vehicles ratio's in Europe in 2018 (1)

(1) Falchetta, G., Noussan, M., 2021. Electric vehicle charging network in Europe: An accessibility and deployment trends analysis. Transp. Res. Part D Transp. Environ. 94, 102813.



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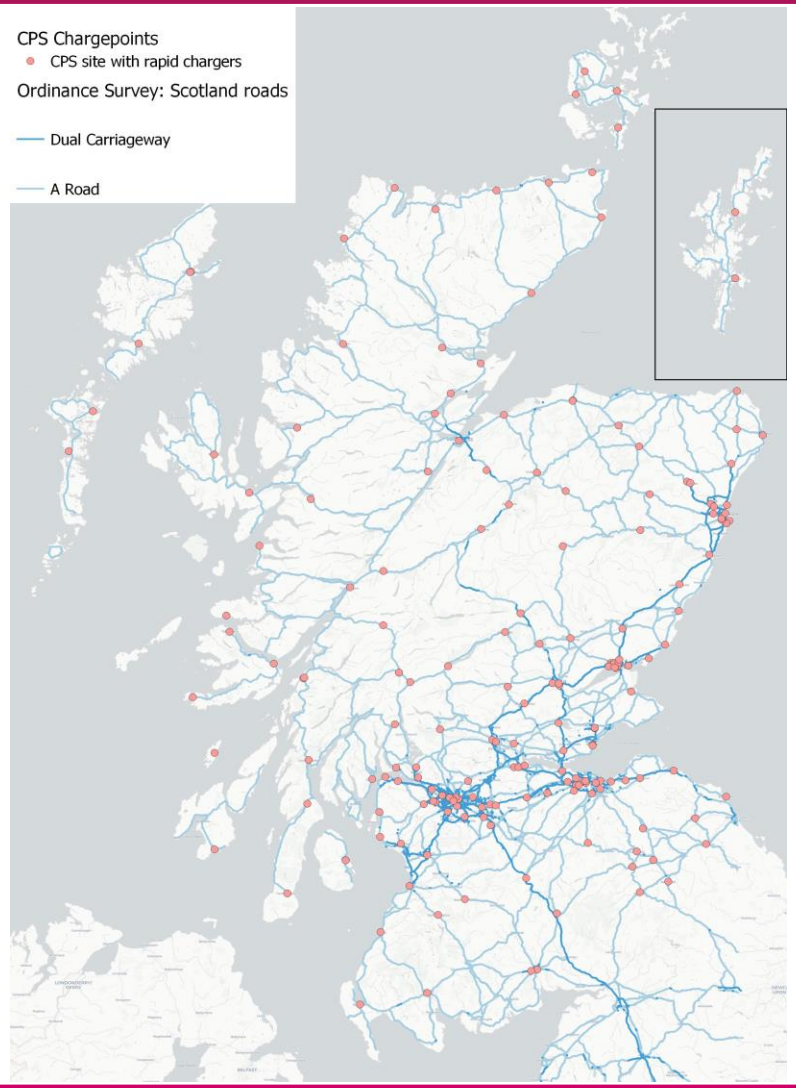

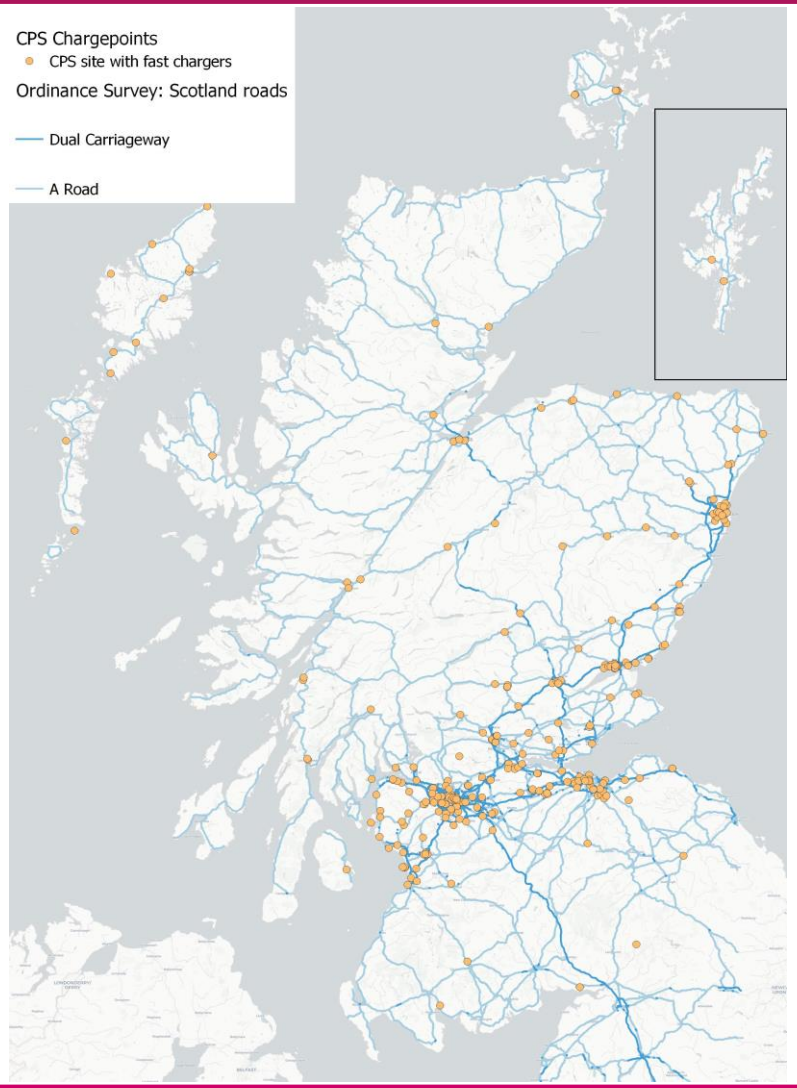

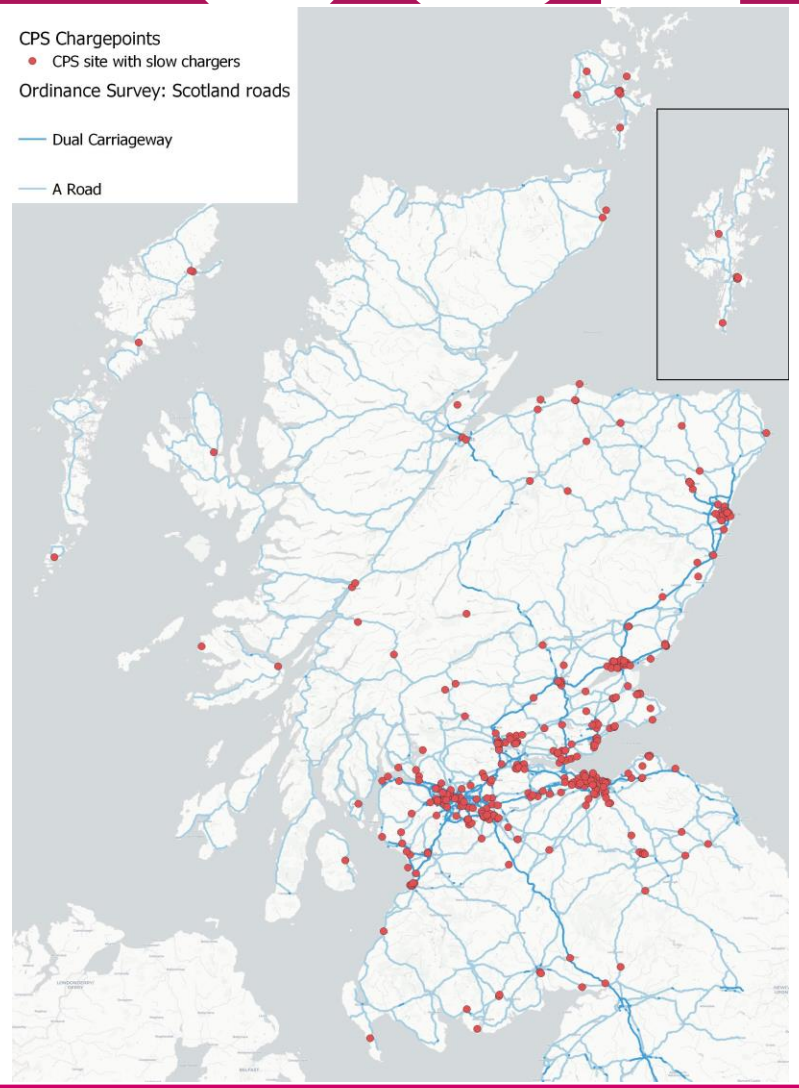

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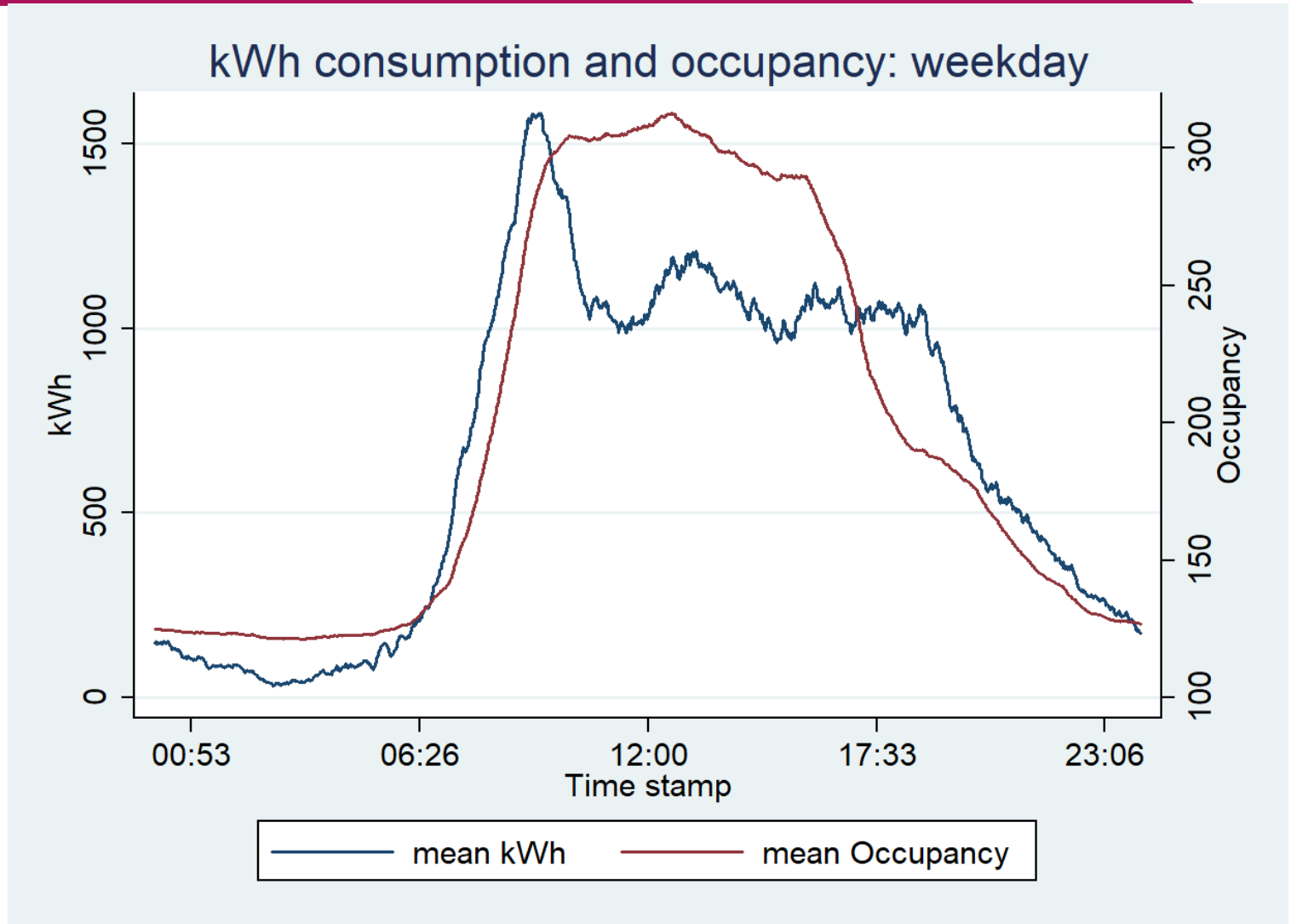

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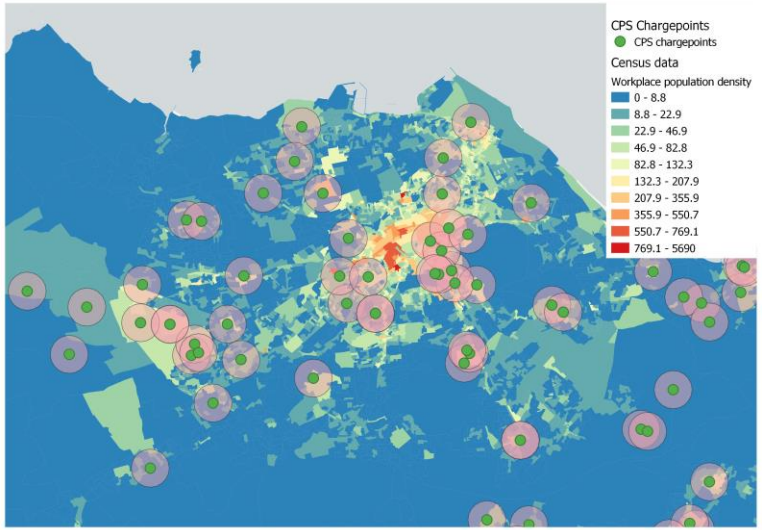
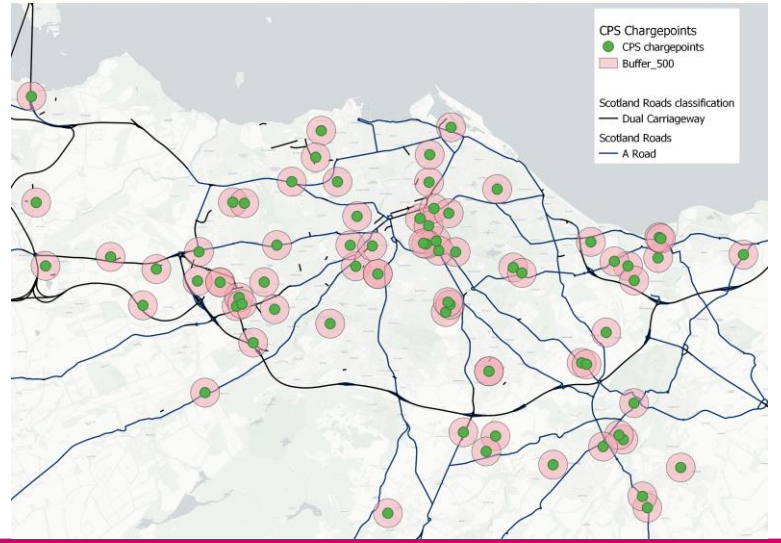
Two stage cluster analysis

- First stage: EV data cluster analysis
  - Selection of EV demand related variables
  - K means cluster analysis
- Second stage: Cluster description using:
  - CPS data (e.g. number of chargers per site)
  - Scottish Census (2011) data (e.g. pop dens, workpop dens)
  - Other contextual sources
    - ONS data (road network/railway stations)
    - Overpass data (e.g. shop density)





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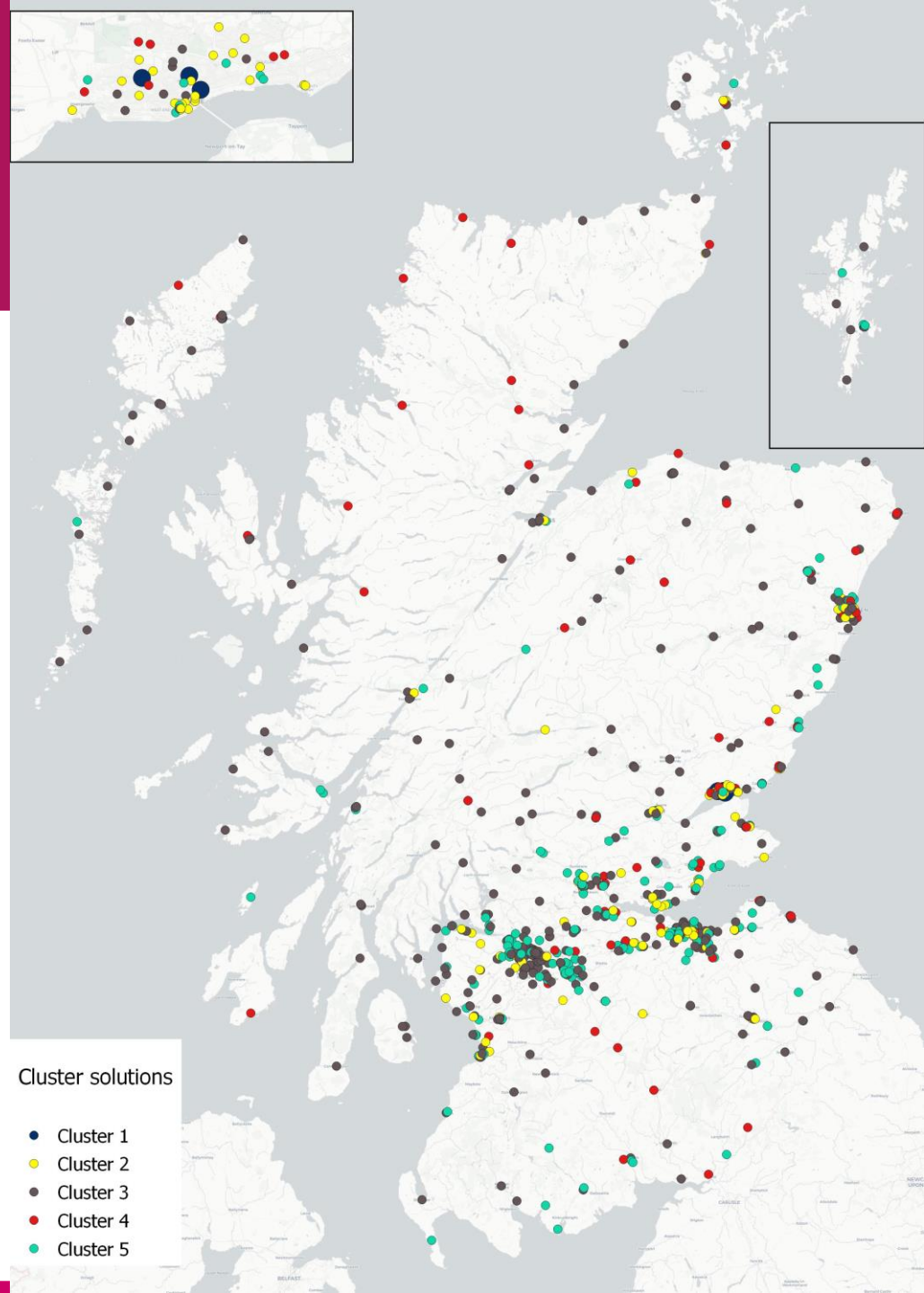
Cluster ID	Sites count	Daily charge events (mean)	kWh consumption (median)	% Site utilisation (mean)	%Morning charge events (mean)
1	3	**70.55**	9.7	**16%**	30%
2	135	**3.5**	7.6	**20%**	41%
3	365	1.9	7.4	4%	39%
4	78	0.9	**15.7**	6%	44%
5	198	0.8	8	6%	**72%**



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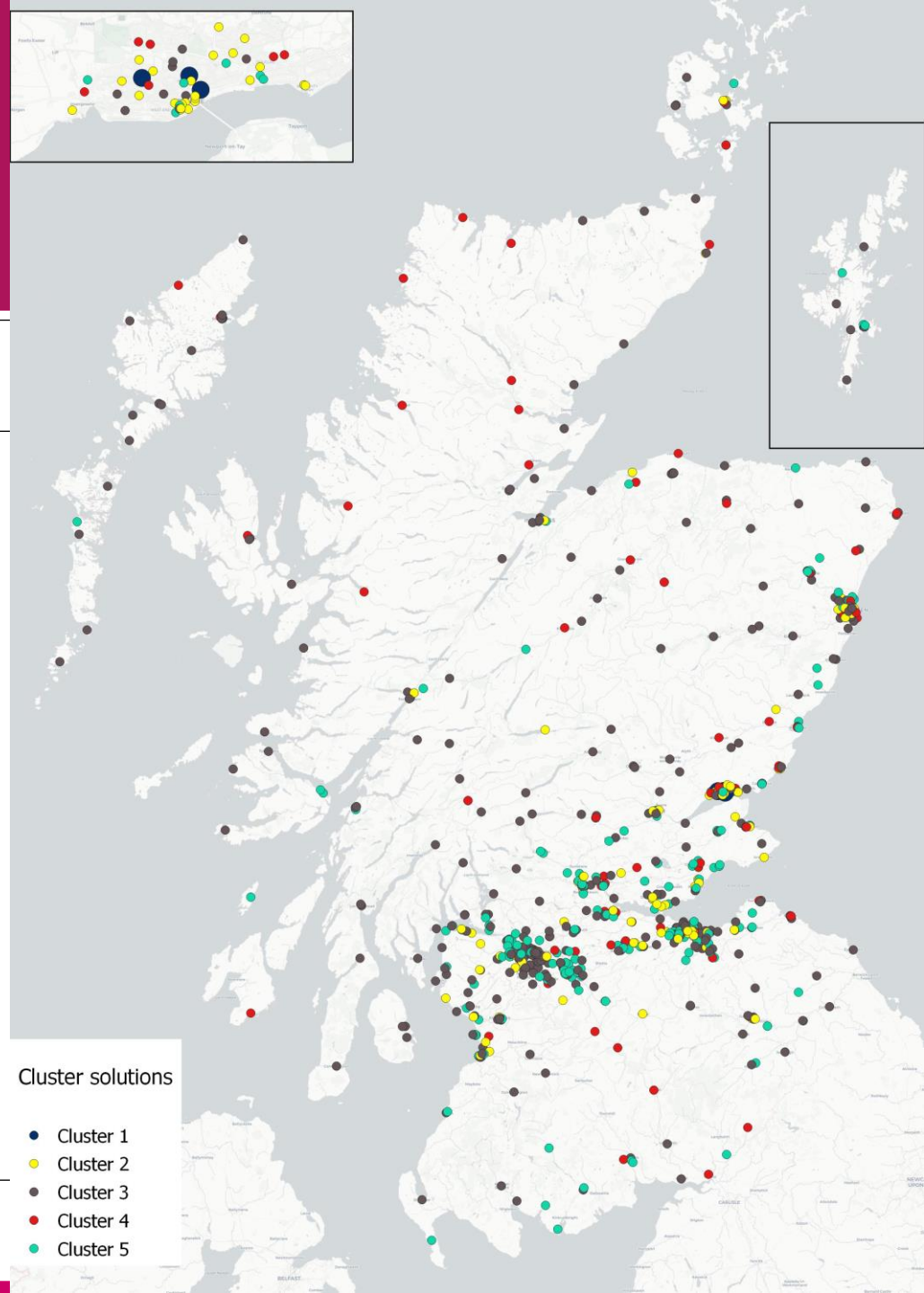
Cluster id	***1***	***2***	***3***	***4***	***5***
Charging stations per cluster (sum)	*3*	*135*	*365*	*78*	*198*
Demographic characteristics					
Resident population density per hectare (mean)	**104.7**	72	53.3	**34.3**	52
Workplace population density per hectare (mean)	24.8	**35.8**	22.8	10.8	22.8
Cars per household (mean)	**0.56**	0.93	1.08	**1.16**	1.11



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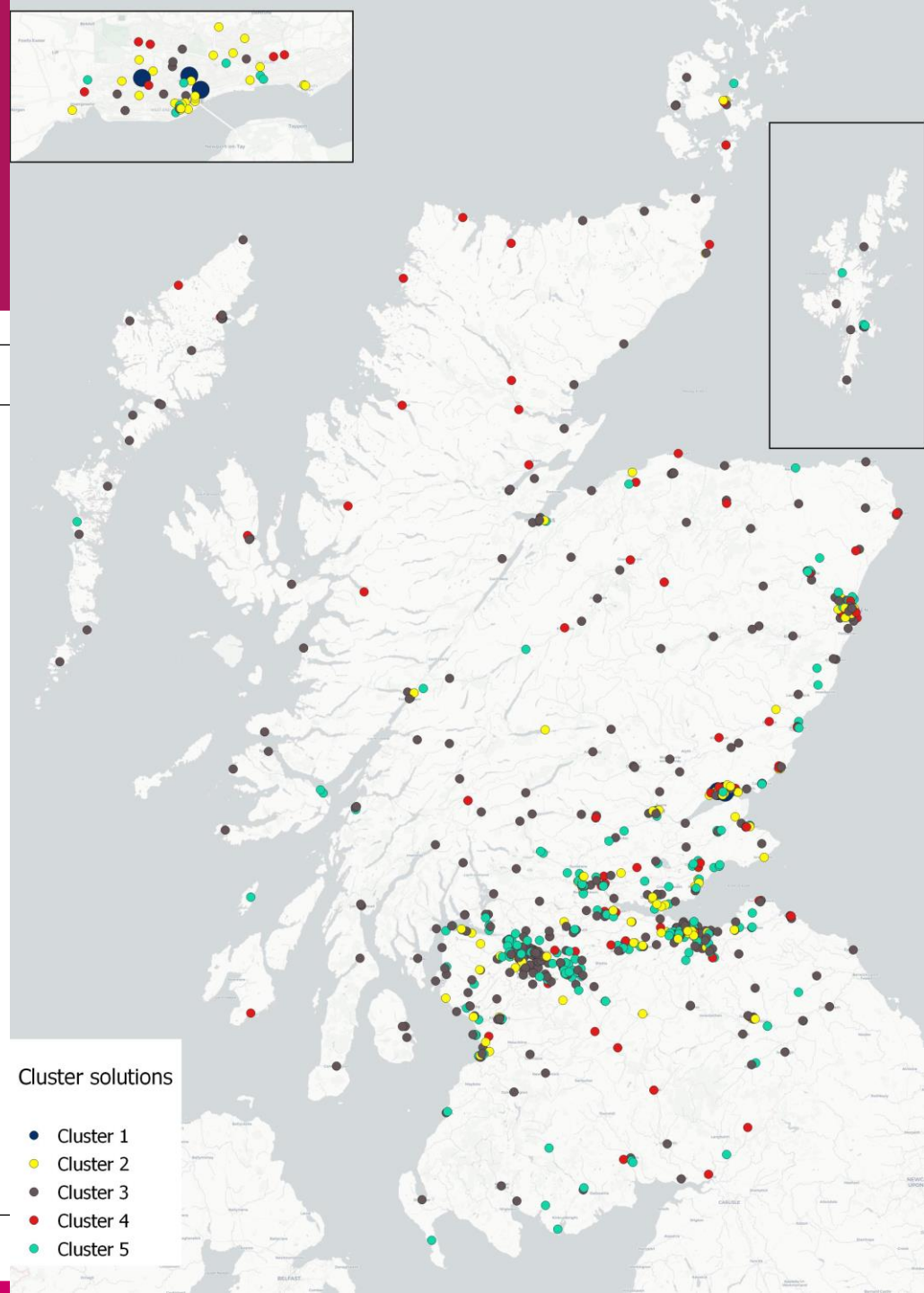
Cluster id	***1***	***2***	***3***	***4***	***5***
Built environment characteristics					
Dwellings: Percentage Flats/Tenements (mean)	**74%**	**50%**	36%	27%	38%
Distance to nearest charging station in kilometres (mean)	0.5	2.7	7.7	**12.4**	4.9
Number of charge points per charging station (mean)	**20**	3	2.7	2.1	2.7
Percentage rapid charge points (43 to 50 kW) per charging station (mean)	**62%**	8%	32%	30%	3%
Percentage of charging stations with Dual Carriageway within 500 meters (mean)	**67%**	**61%**	37%	26%	48%
Number of shops within 500 meters of the charging station (mean)	18.3	**31**	18.4	9.2	12.6



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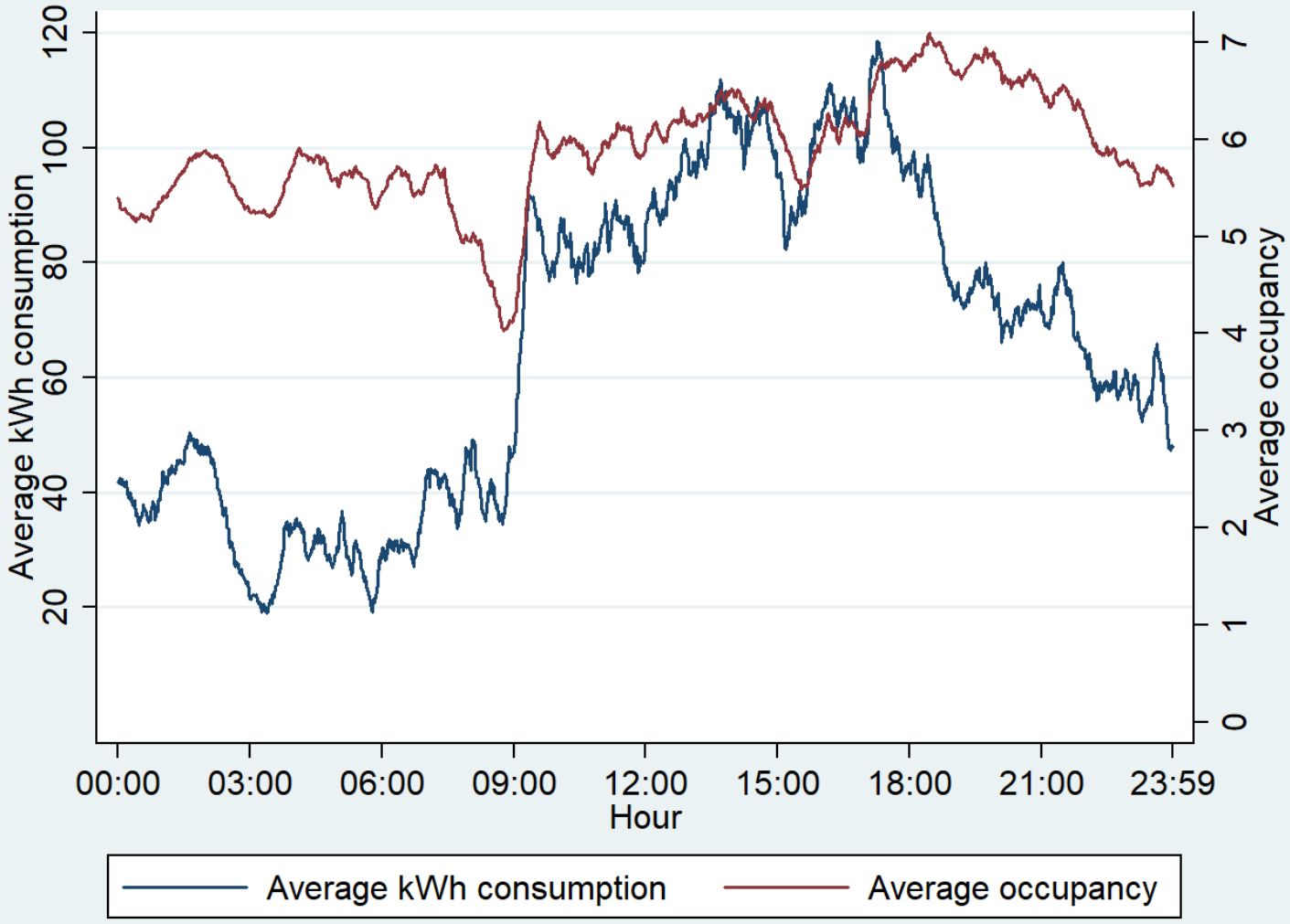

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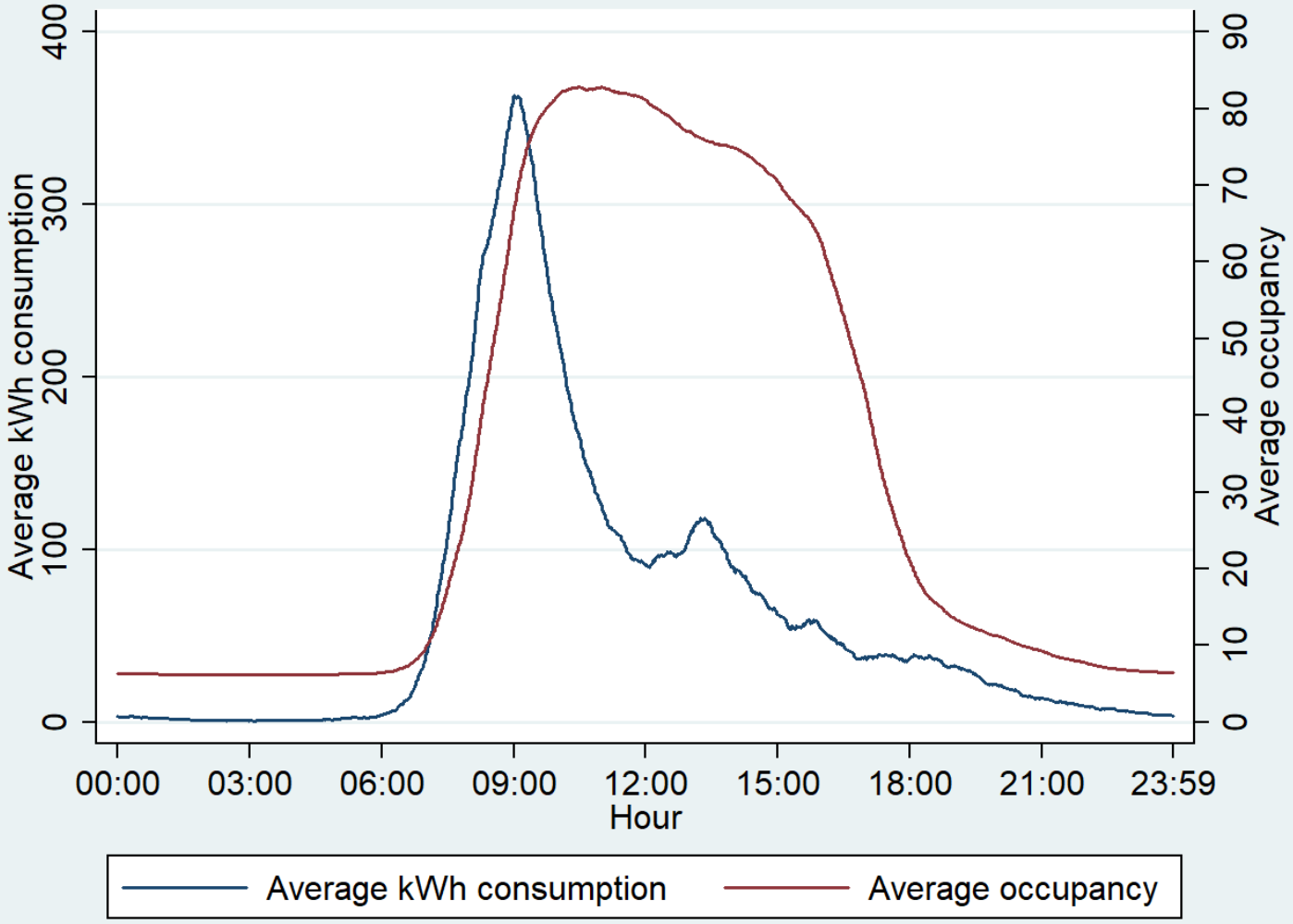

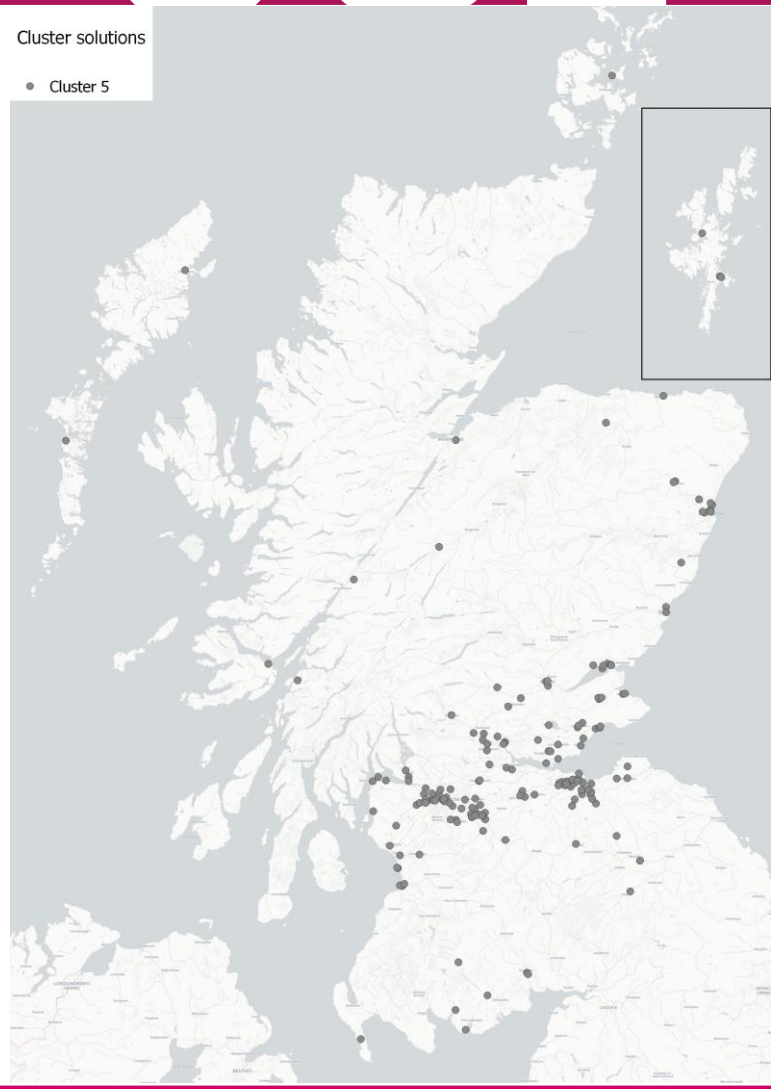

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Discussion

- High population/workplace population density and/or high shop density and/or EV charging infrastructure density associated with high demand for EV charging.
- EV chargers in ‘EV charging deserts’ generally attract high energy consumption per charge event even though demand at these sites is usually low (see cluster 2).
- Scope for ‘smart charging’ especially prevalent at workplace oriented sites, and sites with high share of overnight charging. In general, charge event durations are long.
- Commercially, rapid chargers may not always be suitable
- Local policies to stimulate EV adoption potentially have an enormous impact on EV charging patterns (cluster 1)