Supermarket Solar Powered Electric Cars in Manchester

1.0 INTRODUCTION

Scientists agree that climate change is being caused by the emission of greenhouse gases, like carbon dioxide, from the burning of fossil fuels. In order to tackle climate change we must reduce our carbon emissions. One way we can do this is by powering vehicles with electricity generated from renewable energy rather than with fossil fuels (petrol or diesel).

For this assignment I have chosen to answer the question ‘how much of Manchester’s private electric car charging demand could be met by rooftop solar on supermarkets in the area?’. This is an interesting question because Manchester in the UK is not known for its sunshine. It’s a valuable question because solar panels can be installed on roofs relatively quickly (compared to building wind turbines). And for a densely packed city it’s the main (if not only) solution for local electricity generation. With regards to the supermarket element of the question, even in a lockdown the majority of the population still go to supermarkets, on average on a weekly basis. Supermarkets are usually large flat roofed buildings which present an ideal area for the installation of solar panels.

1.1 Audience/Interest

The answer to this question (‘how much of Manchester’s private electric car charging demand could be met by rooftop solar on supermarkets in the area?’) can be used by:

- policy makers and or Local Authorities to set targets and incentives for the installation of solar panels on supermarkets and installation of electric vehicle charging points in supermarket car parks,
- community interest groups - to campaign for the rollout of local charging points and solar panel installations,
- supermarket owners, solar panel installers, charging network operators and others to establish the business case and seek investment or funding for the rollout of electric vehicle charging points and solar panels.

2.0 DATA

The following data will be used in the project:

1) CSV of Manchester postcodes showing districts and wards by latitude and longitude, Source: https://www.doogal.co.uk/UKPostcodes.php?Search=M (June, 2020)
2) Geojson file of Manchester wards, Source: https://martinjc.github.io/UK-GeoJSON/json/eng/wards_by_lad/E08000003.json (June, 2020)
3) Foursquare supermarket venue search (June, 2020)
4) The solar potential identified for Manchester, Source: Google Environmental Insights Explorer (June, 2020) https://insights.sustainability.google/places/ChIJ2_UmUkxNekgRqmv-BDgUvtk/download

The first data source also includes the distance to a train station for each postcode and the average income for each postcode.

The second and third data sources are self-explanatory.

The fourth data source shows solar potential data in MWh/year. It says for example that in Manchester 271 flat roofs provide 195,000 MWh/year solar potential. Hence we will use this as a proxy to calculate solar potential of supermarket roofs.

It's important to understand the methodology and assumptions used by Google Environmental Insights, these are as follows: Google Earth imagery is used to analyse roof shape and local weather patterns to create an aggregated solar potential estimate.

- Sunlight: Every included panel receives at least 75 percent of the maximum annual sun in the county or city (depending on data availability).
- Installation size: Each panel is assumed to be 250 Watts with an efficiency of 15.3 percent, a DC to AC derate factor of 85 percent and industry-standard assumptions about other factors. Every included roof has a total potential installation size of at least 2kW and fewer than 1,000kW.
- Space & obstacles: Only areas of the roof with enough space to install four adjacent solar panels are included. Only solar arrays on buildings are considered, not other spaces such as parking lots or fields.

As a result of the latter point, all small supermarkets are removed.

Then assuming an electric car charge rate of 7 (or 22kW/h), calculating the total number of sunlight hours that coincide with supermarket opening hours, the distance gained for average distance travelled by electric cars with the power as identified by the solar potential multiplied by time multiplied by charge rate.

The above two help convert the carbon offset value

Where sunlight hours go beyond the supermarket opening times (in summer) would people leave their car in the supermarket to charge anyway to make use of the energy being generated? There is insufficient data for this and so, with the data and time available we will assume that they can and will do this. (An alternative hypothesis could be that excess energy generated is stored in batteries on premises for people to use in the future so that minimal energy is wasted (inefficiencies of technologies)).

2.1 Data cleaning

Of the 47 fields available in the Manchester postcodes CSV the 5 fields were selected for use (as shown below), these fields were fully populated.

	Ward	Latitude	Longitude	Distance to station	Average Income
0	Ancoats & Beswick	53.481207	-2.213571	0.922572	36448.469388
1	Ardwick	53.465806	-2.216967	0.877121	28371.785714
2	Baguley	53.391012	-2.284313	2.852126	33244.086022
3	Brooklands	53.406493	-2.296415	3.291382	36283.419689
4	Burnage	53.431516	-2.203527	0.589623	36351.463415
5	Charlestown	53.524126	-2.190979	1.414367	33480.731707
6	Cheetham	53.501020	-2.241741	1.561111	34973.262032
7	Chorlton	53.442847	-2.279975	2.473974	48407.339450
8	Chorlton Park	53.435098	-2.267336	3.187115	47054.272517
9	Clayton & Openshaw	53.478961	-2.176137	1.130757	29672.712146
10	Crumpsall	53.515799	-2.238195	3.218195	32701.212121

Figure 1: Table extract for cleaned Manchester ward data.

The Foursquare API search for supermarkets yielded duplicates in the same place (where multiple shops may be in the same building for example), these had to be removed. MoneySupermarket or Car Supermarket also came up, so anything that referenced Money or Car also had to be removed.

In the search for shops of the supermarket chain Tescos, some Mobile, Optician and Pharamacy shops were returned, so Tescos had to be filtered on the ‘supermarket’ or ‘grocery store’ category in order to clean the data.

3.0 Methodology

It as felt that clustering was not needed due to the sparse data and the wards acting as groupings for the data available. Instead choropleth maps were produced

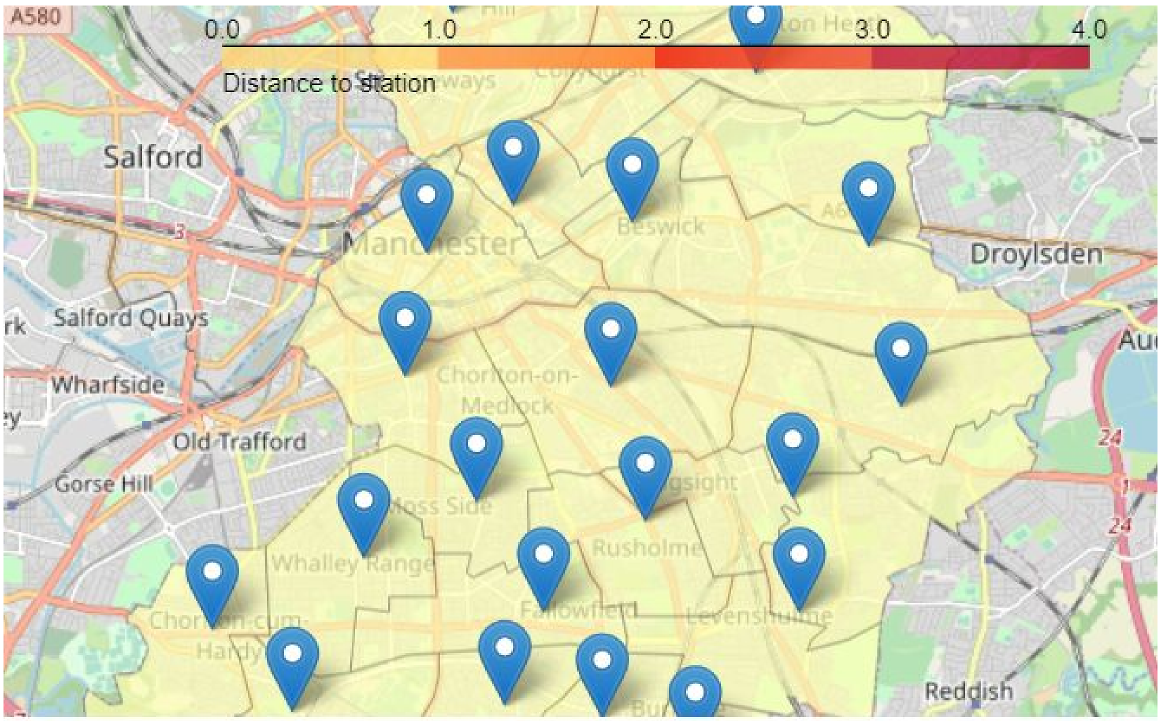

Figure 2: Choropleth map showing Manchester wards and their average distance to station.

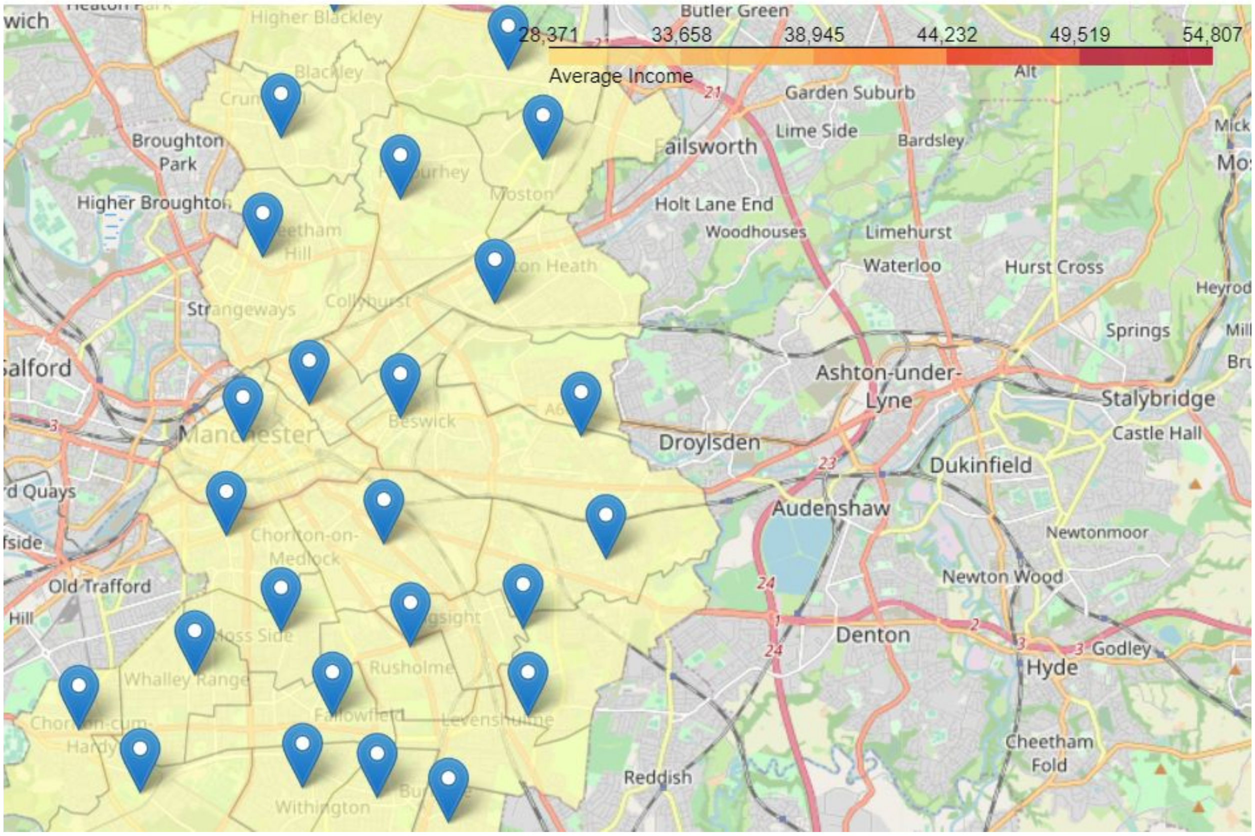

Figure 3: Choropleth map showing Manchester wards and their average income.

It is thought that a higher income means increased likelihood of using private transport and in particular an electric car. Also the further from a station the higher the need for private transport. To test whether there is a relationship between Distance to Station and Average Income of a ward a scatter plot was drawn

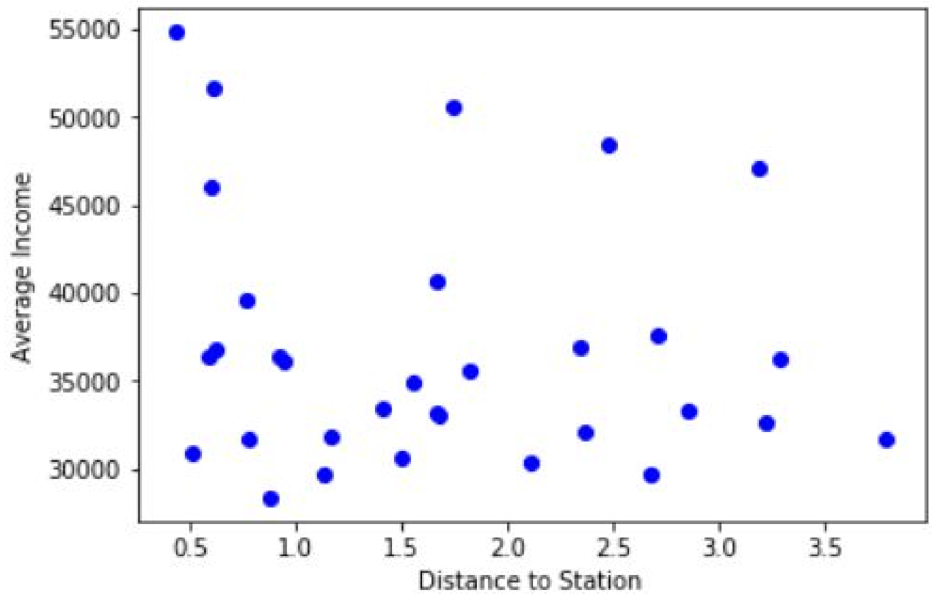

Figure 4: Scatter plot shows no correlation between the ward's average income and average distance to station.

4.0 Results

Choropleth map shows the average income of each Manchester ward, markers show the ward name and red circles show locations of the 'Tesco' supermarket chain.

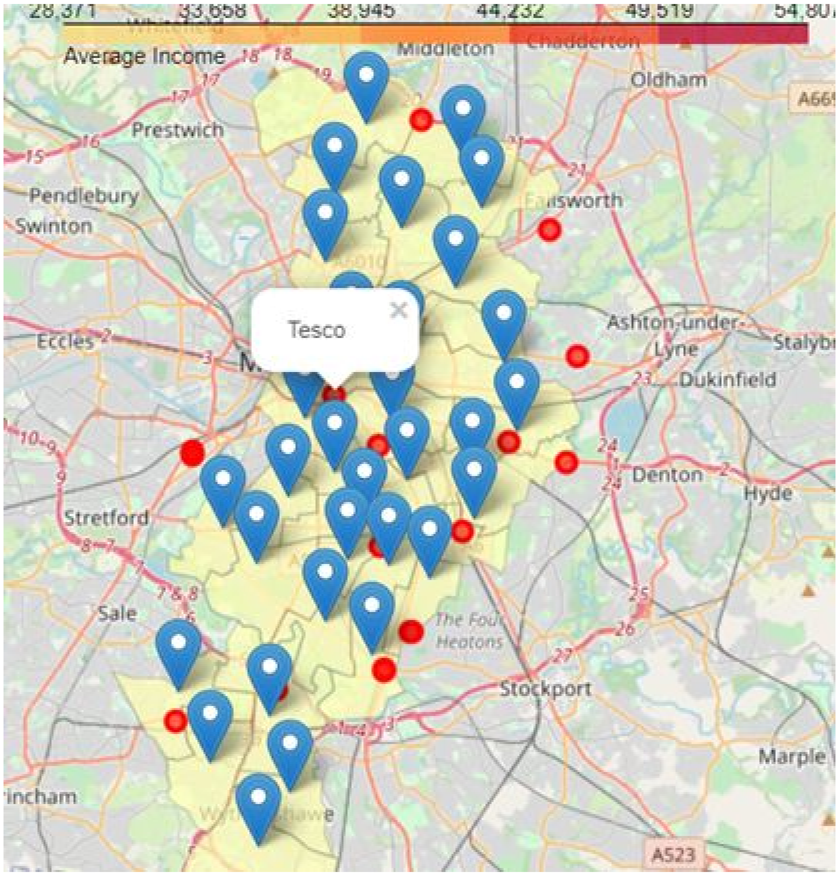

Figure 5: Choropleth map showing Manchester wards and their average income and supermarkets (red circles).

5.0 Discussion

The hypothesis of whether those wards that are further from a station use private transport more needs to be assessed, perhaps in combination with information about other public transport use.

Type of housing and housing ownership by ward would be a useful data source to determine where home charging will and will not be possible or probable. This would be another factor in the decision on the areas where public charging is needed sooner.

6.0 Conclusion

Unfortunately there are no conclusions to be drawn from the data and analysis done to date.