TARGETING RESIDENTIAL AREAS FOR RETROFIT

Ang Li-Lian
Fellow

Meghna Asthana
Fellow

Mike Coughlan
Fellow

Shriya Kamat Tarcar
Fellow

Satyam Bhagwanani
Project Manager

Mihir Mehta
Technical Mentor

Data Science for Social Good
DSSGx UK Summer Fellowship

WARWICK THE UNIVERSITY OF WARWICK

West Midlands Combined Authority

PURE LEAPFROG

A B C D E F G

OBJECTIVES

West Midlands Combined Authority
- 33% reduction in carbon use across local transport, homes and businesses by 2026
- 100% carbon neutrality by 2041
- Evidence-based green urban planning and policy-making

Pure Leapfrog
- Combat climate change in a socially inclusive way, working with local communities and social enterprises

PROBLEM

- An evidence-based strategy is required to determine areas for retrofitting.
- Energy Performance Certificate (EPC) ratings can be used as an indicator and are only available for 40% of the 1.2 million homes in the West Midlands.
- The implications of installing solar panels and electric heat pumps on the electrical network are unclear.
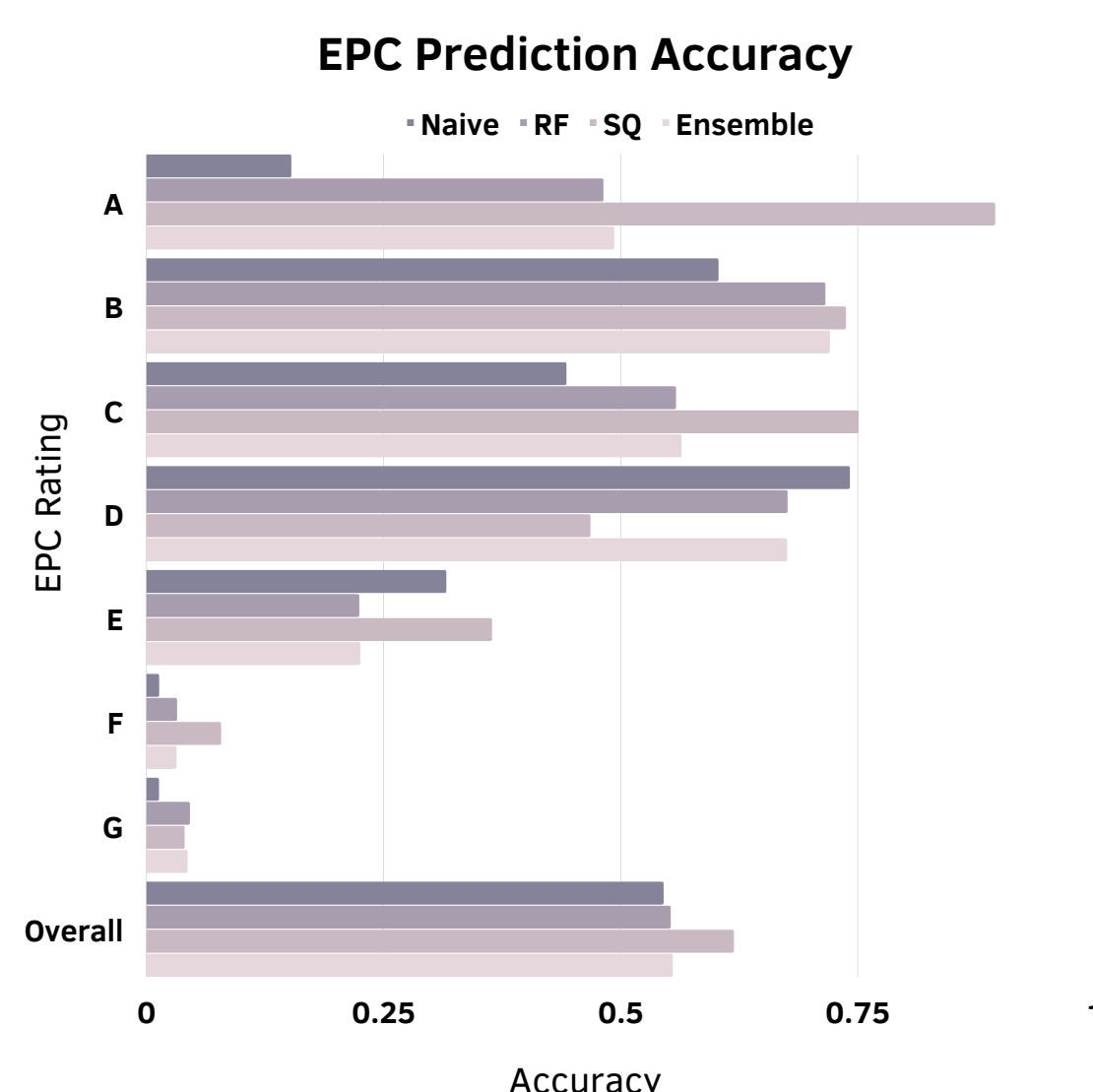
GOALS

- Predict EPC ratings of the remaining 60% of houses in the West Midlands
- Identify solar panel-ready areas
- Determine the implication of switching to electric heating on the electrical network
- Deploy a tool for visualising and presenting insights

PREDICT EPC RATINGS

- Merged EPC, Ordnance Survey Master Maps (OSMaps), fuel poverty and electricity consumption data and trained several machine learning models.
- Each model was trained to predict the EPC rating and heating type of houses using data available for all homes (i.e. floor area, height, address).
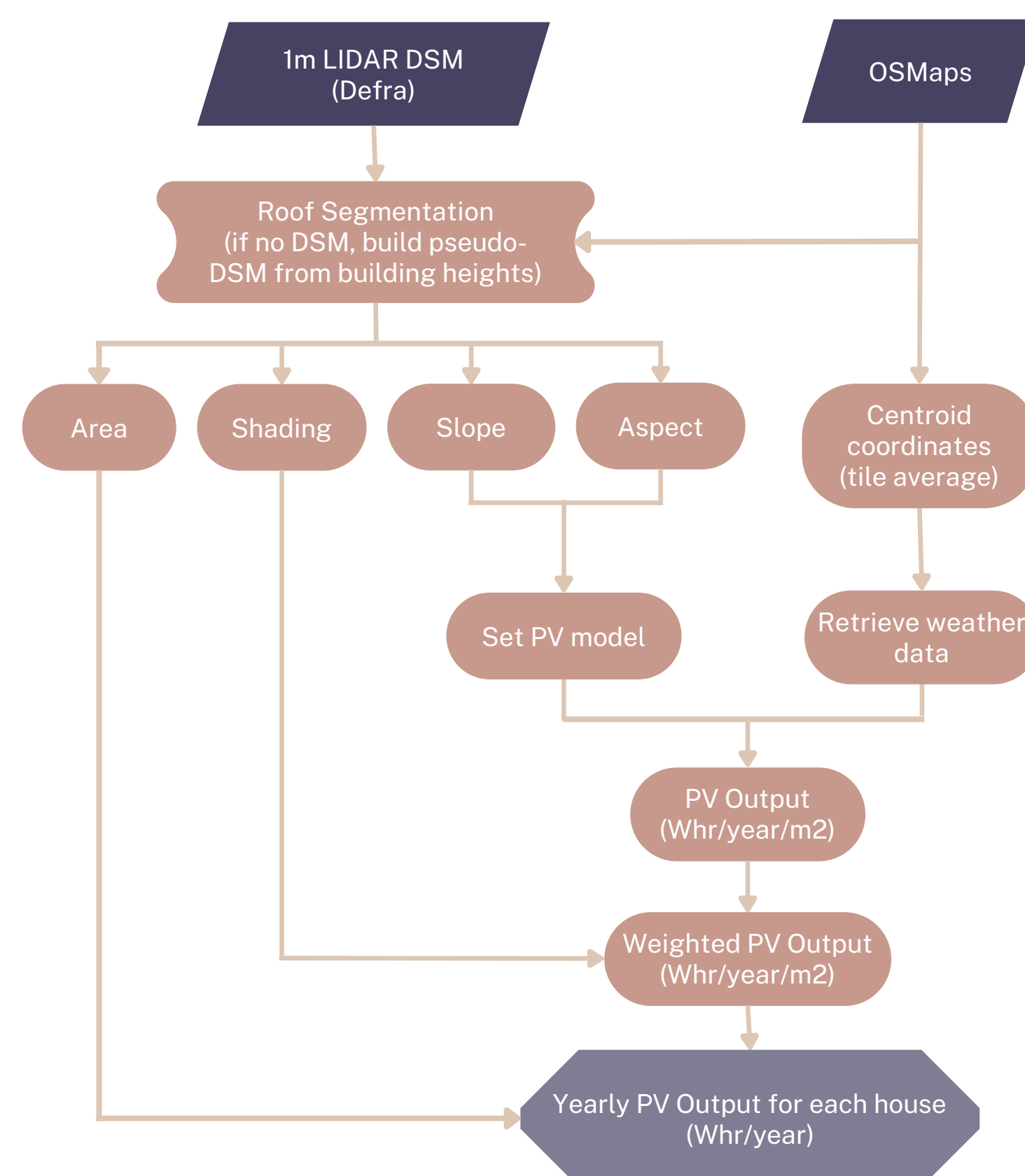- Selected best model on F-1 and accuracy score and better performance on lower rated houses.

Results
- Improved prediction accuracy for all ratings compared to the baseline for random forest (RF) and similarity quantification (SQ) model.
- SQ model only works if a matching home is found, so it is combined with the RF model to cover homes without a match.

EPC Prediction Accuracy

Naive · RF · SQ · Ensemble

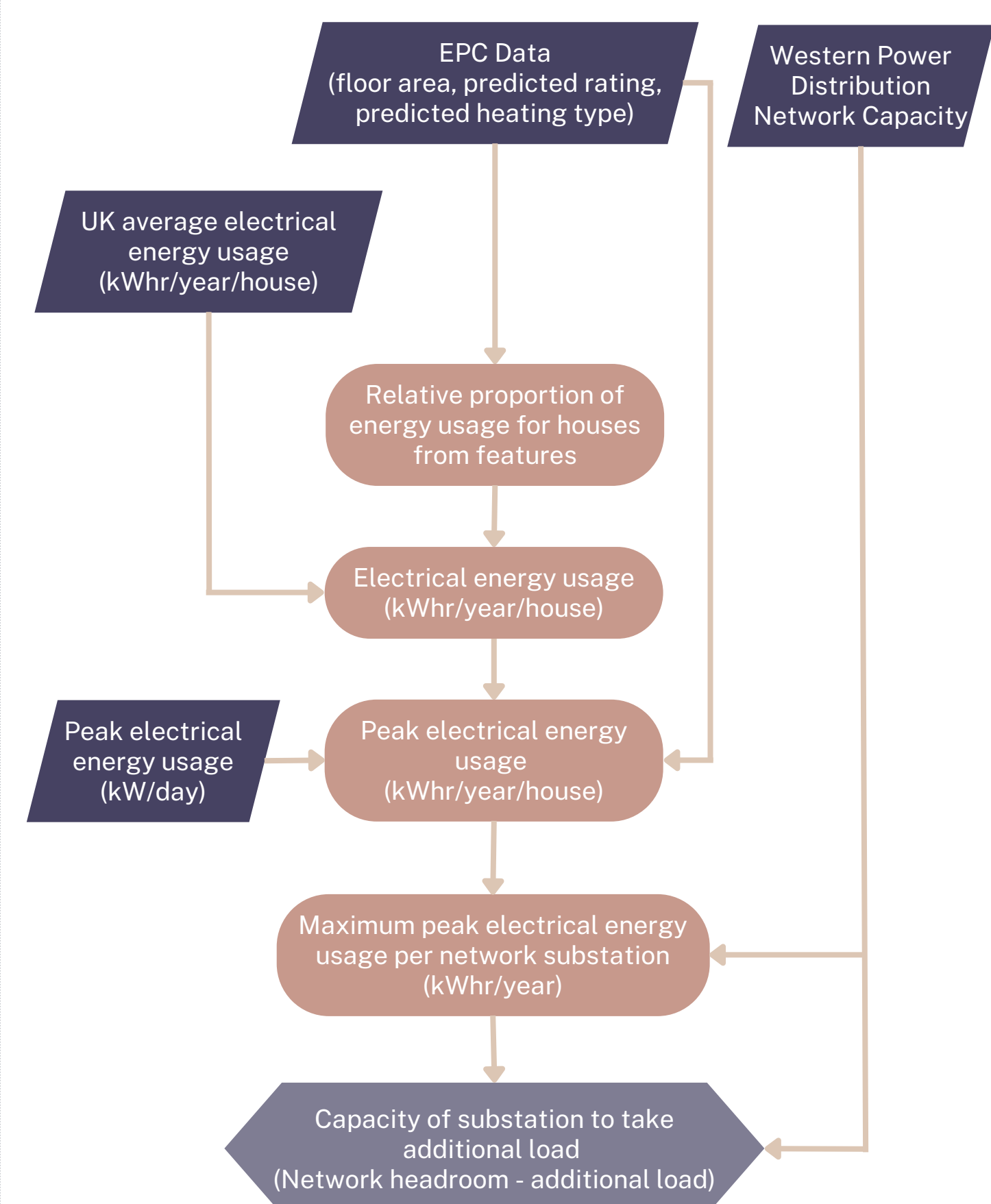(Bar chart: EPC Rating A, B, C, D, E, F, G, Overall vs Accuracy 0 to 1)

ESTIMATE SOLAR PV OUTPUT

- Segmented house roofs for areas with a DSM layer using Digital Surface Model (DSM) data and OSMaps.
- Estimated shading on roofs from other buildings, creating a pseudo-DSM where necessary.
- Calculated estimated solar PV output using the formula from the Microgeneration Certification Scheme (MCS).

(Flowchart:)
- 1m LIDAR DSM (Defra)
- OSMaps
- Roof Segmentation (if no DSM, build pseudo-DSM from building heights)
- Area
- Shading
- Slope
- Aspect
- Centroid coordinates (tile average)
- Set PV model
- Retrieve weather data
- PV Output (Whr/year/m2)
- Weighted PV Output (Whr/year/m2)
- Yearly PV Output for each house (Whr/year)

ADDITIONAL NETWORK LOAD

- Using EPC predictions, national electricity consumption and regional network capacity data, we calculated the maximum additional load on the electrical network for homes switching to electric heating.
- Derived individual home energy usage from national energy statistics and estimated heating costs.

(Flowchart:)
- EPC Data (floor area, predicted rating, predicted heating type)
- Western Power Distribution Network Capacity
- UK average electrical energy usage (kWhr/year/house)
- Relative proportion of energy usage for houses from features
- Electrical energy usage (kWhr/year/house)
- Peak electrical energy usage (kW/day)
- Peak electrical energy usage (kWhr/year/house)
- Maximum peak electrical energy usage per network substation (kWhr/year)
- Capacity of substation to take additional load (Network headroom - additional load)

IMPACT

- UK city councils can identify areas with houses that should be targeted for retrofitting.
- Solar PV output estimations can guide policies for potential funding or subsidies to different areas.
- Energy capacity calculations can inform which areas might cause electrical grid issues during planning.

FUTURE WORK

We encourage other councils in the UK to adopt and improve on the open-source pipeline and visualisation tools we have developed, to guide evidence-based policy-making and urban planning.