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A Data-Driven Analysis of Residential Building Energy Performance in Manchester

Using EPC Data, SQL Server, and Power BI

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1. Introduction

In the United Kingdom, there has been an increasing concern in enhancing building energy efficiency with the rising energy prices, increasing concerns on global warming and the need to reduce carbon emissions. Domestic and commercial building industry is a major source of energy consumption and greenhouse gas emissions in the country, and it is one of the key areas where the policy can be applied. The UK government has responded to this by formulating some regulations and assessment systems to ensure that they monitor and improve building energy performance, the best of which is the Energy Performance Certificate (EPCs).

Energy Performance Certificates are documents that assess the energy efficiency of a building in the form of a rating that will be between A (most efficient buildings) and G (least efficient buildings). The EPCs also contain data concerning the existing energy performance, the available energy improvements, the approximate energy cost, and the carbon dioxide (CO_2) emissions. When the properties are built, sold and rented, these certificates are legally obligatory, and EPC data can be considered a good and comprehensive source to study the energy performance of the building stock during a certain time.

Manchester is one of the largest metropolitan regions of the United Kingdom, which offers a wide range of housing and buildings containing old and new constructions. Diversity generates many differences in energy performance in various neighbourhoods and types of properties. The analysis of the EPC data concerning Manchester, therefore, presents a possibility to find trends, disparities, and possible areas where energy efficiency can be targeted to enhance the local and national sustainability goals.

This research paper would be an analysis and visualisation of the data of Energy Performance Certificates of properties in Manchester in the period 2014 and 2024 using Power BI. The analysis is conducted with interactive dashboards to explore overall tendencies in the energy performance, geographic differences within the city, the contribution of property and building characteristics, and the advantages of improving the energy performance to the environment, which can be achieved. The project demonstrates that data analytics and visualisation may be used to guide policymakers, stakeholders in the energy industry, and local governments to make evidence-based decisions that can contribute to carbon emissions reduction and building energy performance improvement by transforming raw EPC data into valuable information.

2. Methodology

2.1 Dataset Description and Acquisition

The data used in the analysis is the publicly accessible Energy Performance Certificate (EPC) data in England and Wales with the properties in the Manchester local authority during the period 2006-2025. Every record will be associated with an EPC assessment undertaken upon the construction, sale, or rent of a property

The data set consists of key energy performance indicators as current and potential energy efficiency scores, EPC ratings (A-G), CO 2 emissions, and energy-related expenses (heating, lighting and hot water). Besides, building characteristics such as property type, construction age, total floor area, heating, fuel type, glazing and insulation are captured. Spatial analysis of energy performance in Manchester can be done using geographic identifiers, e.g. postcode and constituency.

Although EPC assessments indicate the situations during the inspection and might not fully reflect the behaviour of occupants and the real consumption pattern, EPC assessments offer a strong foundation for comparative analysis and potential improvement. The data was acquired in the UK government portal and filtered specifically to properties located in Manchester between the years 2006 and 2025, so that the analysis is regionally applicable and in compliance with the policy of sustainable energy.

2.2 Data Storage and Cleaning

The filtered data was loaded into SQL Server to facilitate structured storage, efficient querying, and data transformation that can be reproduced. The preliminary exploratory data analysis was performed to reveal any missing data, duplications, and inconsistencies. Stored procedure (CleanInvalidStrings) was used to convert invalid strings like "NO DATA!", "Unknown" and N/A to a null.

More columns were removed, which were not necessary to analyze the data, and duplication was ensured to be eliminated. Several T-SQL views were developed to structure major datasets to be used in Power BI visualisation, and these include:

- Property identification and location (vw_EPC_Property_Info)
- Energy ratings and efficiency (vw_EPC_Energy_Ratings)
- Carbon emissions (vw_EPC_Carbon_Emissions)
- Cost analysis (vw_EPC_Costs)
- Property characteristics (vw_EPC_Property_Characteristics)
- Building fabric, heating systems, lighting, and renewables

The SQL scripts and transformation queries are all presented in Appendix A to allow reproducibility and validation.

2.3 Data Modelling and Calculation in Power BI

The filtered data set was connected to Power BI to form a full data model. Calculated columns, tables and measures were created in DAX and can be analysed in detail and visualised in dashboards. Key measures include:

- Certificate per year
- Test count
- Total certificate
- Total Recommendation

The dashboards are based on these measures, which are KPIs, bar charts, column charts, line charts, maps, and other interactive visualisations. DAX formulae are given in Appendix B.

2.4 Dashboard Design

The Power BI dashboard has been developed as an interactive and multi-page analytical platform to enable the capacity to tell clear stories and for users to explore the EPC data intuitively and easily. The dashboard is composed of six interrelated tabs that cover a particular analytical goal and share a similar visual layout and design language.

Home Screen

The Home screen serves as the home page of the dashboard. It presents the purpose of the Energy Performance Certificate (EPC) analysis and offers the users contextual information prior to their interaction with detailed visualisations. This page presents a coverage of the dataset, such as the geographic scope (Manchester) and analysis period and gives a description of the scale of EPC energy rating, which is A (most efficient) to G (least efficient).

Overview Dashboard

The Overview dashboard will give a general overview of the energy performance of the Manchester properties. It shows key performance indicators as total EPC certificates, average energy efficiency, CO_2 emissions, environmental impact scores and total recommendations

Property Characteristics Dashboard

This dashboard examines the effect of structural and building-related properties on the energy performance. The visualisations examine the trends in property type, floor height, floor area, roof description, insulation type, tenure, and EPC log dements. Property-type slicers allow studying bungalows, flats, houses, maisonettes, and park homes in detail.

Cost Dashboard

The Cost dashboard examines energy spending, such as heating, lighting, and hot water spending. Visualisations make comparisons between actual and potential costs throughout the years and between property types, wall descriptions, and tenure types. Year, property type, and tenure interactive slicers enable the user to evaluate the changes in the costs depending on different conditions

Energy Efficiency Dashboard

The Energy Efficiency dashboard focuses on the carbon emissions, energy consumption, environmental impact scores, and distributions of EPC ratings.

Recommendations Dashboard

The Recommendations dashboard identifies the potential measures to improve and its advantages. Visualisations include recommended interventions, total cost savings over time, and changes in potential EPC ratings following improvements.

All dashboards are provided in Appendix C.

2.5 Analytical Approach

Descriptive statistics, spatial comparison, and benchmarking are used in the analysis to explore energy efficiency, carbon emissions, and costs associated with energy in the building stock of Manchester. Trends over the analysis period were evaluated to determine the variation in performance, while comparisons across property type, building characteristics and geographical area were employed to indicate variation and potential improvement.

The methodology contributes to the determination of the areas of priority where energy efficiency interventions are to be applied by connecting the indicators of energy efficiency to both environmental and monetary indicators. Transparency and reproducibility are offered, and all the datasets, scripts, and dashboards are provided in the Appendices.

3. Results and Analysis

3.1 Overview Dashboard

3.1.1 Distribution of the average total cost.

The Overview dashboard is a summary of energy performance, environmental impact, and EPC activity at the Manchester properties at a high level. Heating is the largest contributor to average total costs at €570.45, representing 70.96% of total expenditures, while lighting and hot water contribute 19.9% and 9.15%, respectively. These findings in Figure 1 suggest that there can be considerable financial savings in the building stock by making specific improvements in heating systems.

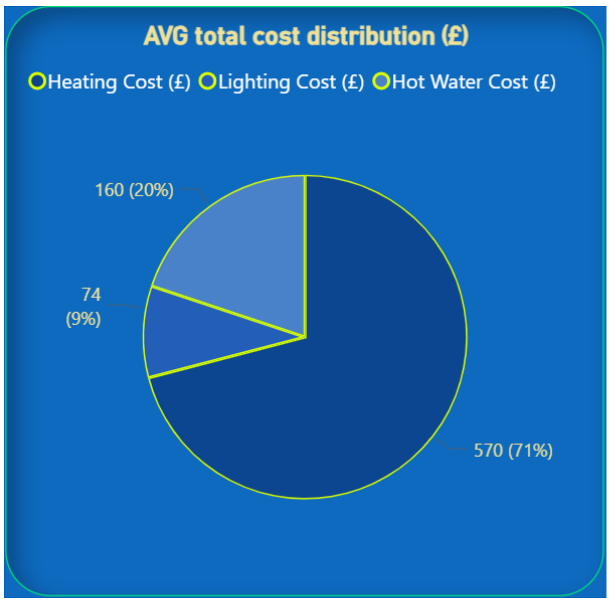


Figure 1: Distribution of the total cost (Average)

3.1.2 CO_2 Emissions, Environmental Impact, and Total Certificates

Average CO_2 emissions across all properties are 3.18 kg/m², with an average environmental impact score of 65.57. It has issued 325.69K certificates with more than 1 million recommendations. This means not only the magnitude of energy evaluations but also the possible impact of efficiency interventions proposed.

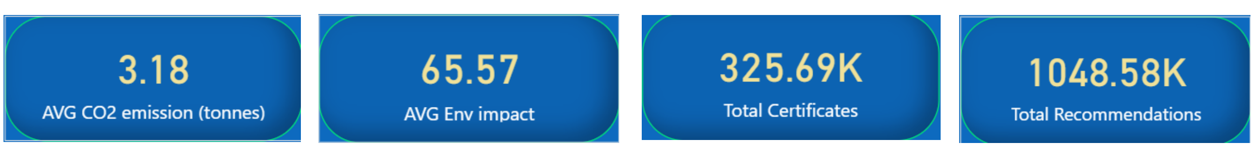


Figure 2: CO^2 Emissions, environmental impact, certificates, and recommendations.

3.1.3 Certificates by Main Fuel Type

Non-community main gas fuels are most often linked to certificates, and the least are the house coal and oil community fuels, as shown in Figure 3. This implies that energy efficiency initiatives can be required to target certain types of fuels to achieve maximum change.

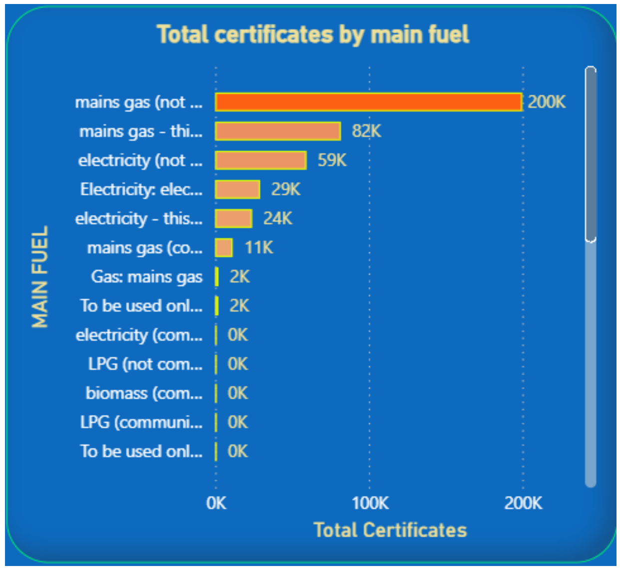


Figure 3: Certificates by Type of main fuels

3.1.4 Certificates by Building Form

The number of certificates is more inclined towards mid-terrace properties, with less prevalence of enclosed mid-terrace buildings. The determination of dominance-building forms helps in the prioritization of property types to be upgraded on energy efficiency by policymakers.

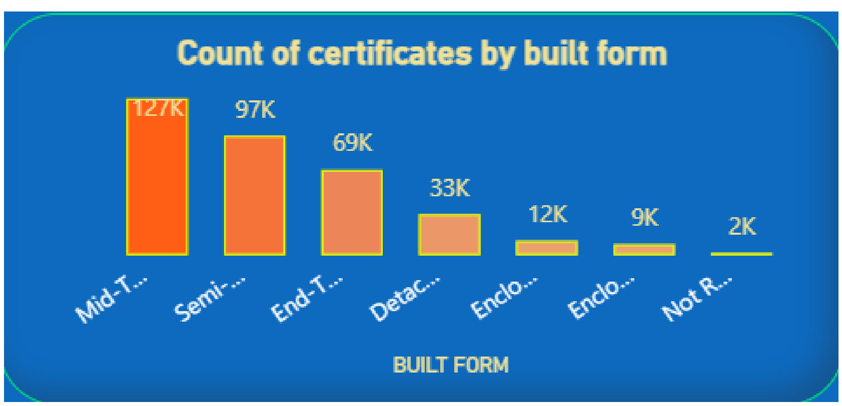


Figure 4: Certificates by Building Form

The entire Overview dashboard with interactive elements and slicers is attached to Appendix C.2.

3.2 Property and Building Characteristics Dashboard.

3.2.1 Average Floor Height and Floor Area by Property Type

The dashboard examines structural attributes and their impact on energy performance. The average floor height of bungalows is 2.42 m with a floor area of 64.40 m^2, the average floor height of flats is 2.49 m and floor area 61.08 m^2, houses 2.52 m and 87.57 m^2, maisonettes 2.49 m and 76.91 m^2, and park homes 2.48 m and 51.00 m^2. These variations shown in Figures 5 and 6 are due to property-specific energy demands and affect heating and lighting demands.

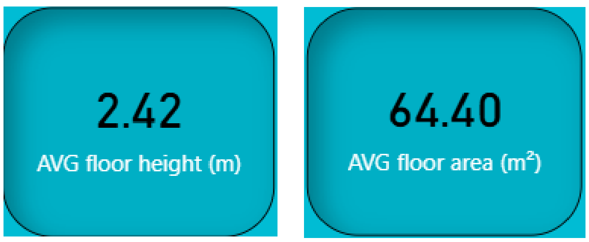


Figure 5: *Average Floor Height and Floor Area - Bungalows*

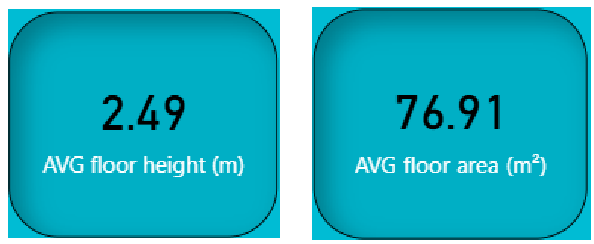


Figure 6: *Average Floor Height and Floor Area - Maisonettes*

3.2.2 Certificates by Roof Description

Designing roofs affects energy efficiency, with the most common roof designs recorded in bungalows being pitched roofs with loft insulation (250 mm) and in flats, report "another dwelling above" roof types. Houses exhibit dominance of 200 mm loft insulation, and park homes have limited data.

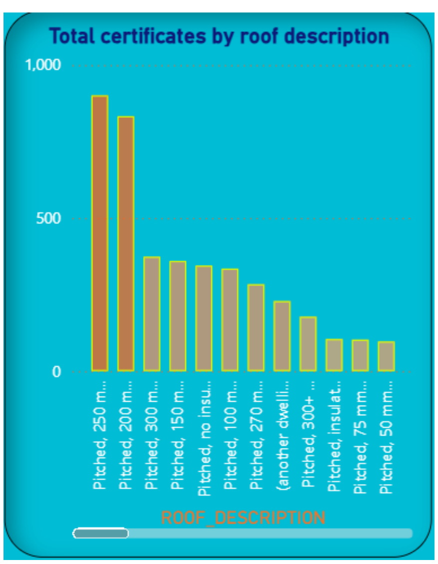


Figure 7: *Certificates by Roof Description - Bungalows*

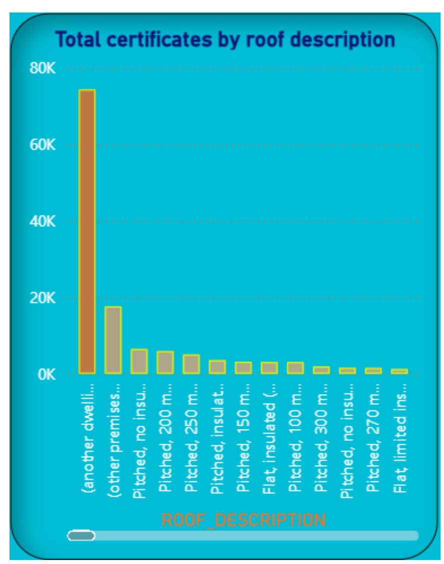


Figure 8: *Certificates by Roof Description - Flats*

3.2.3 Number of lodgements over time

The lodgements as per the type of property are shown in Figure 9. In 2015, lodgements in bungalows are the highest (at about 832) and the lowest in 2008 (97). The highest points of flats and houses are in the year 2009 with the lowest point of flats being in 2007. Overall, the results indicate that lodgements evolve throughout the course of time and differ based on the nature of property.

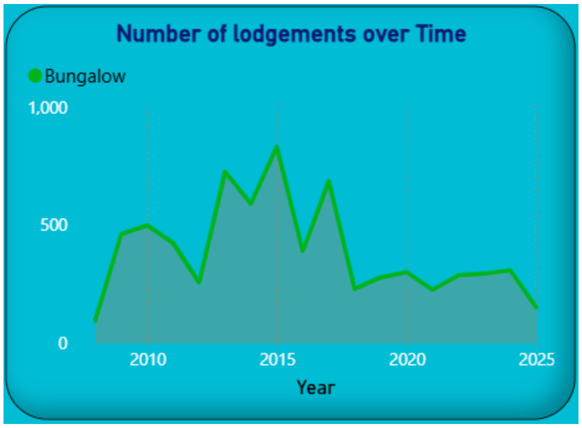


Figure 9: Number of lodgements over time - Bungalows

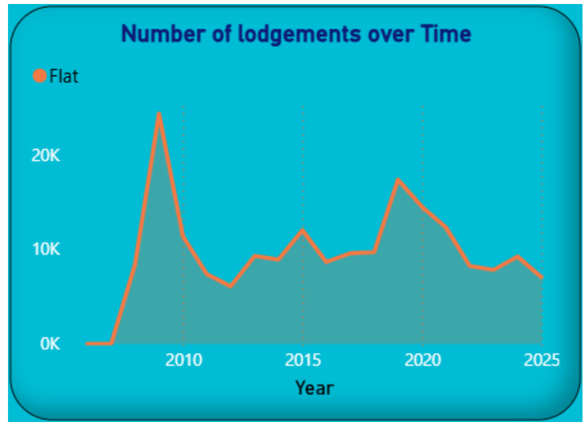


Figure 10: Number of lodgements over time - Flats

3.2.4 Certificates by Tenure

The most prevalent bungalows and flats have a high number of certificates, and houses and park homes have the highest number of owner-occupied properties. This association highlights the effect of tenure on participation in energy efficiency upgrades.

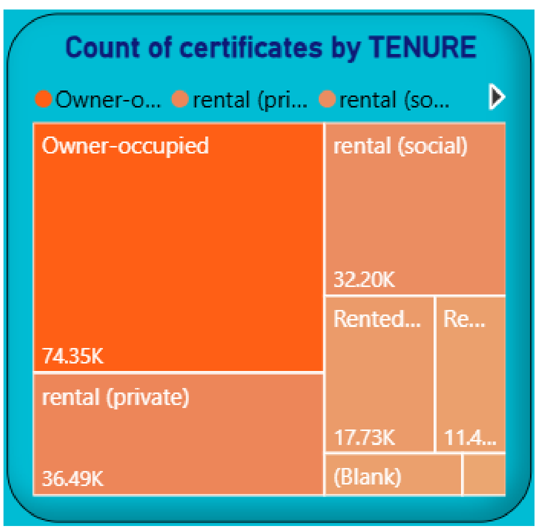


Figure 11: Certificates by Tenure - Houses

The entire dashboard on Property and Building Characteristics is shown in Appendix C.3.

3.3 Cost Dashboard

3.3.1 Average Total Cost Distribution

The cost analysis shows in Figures 12,13,14 that heating has the highest cost in any property. Bungalows have an average heating cost of 564.59 and a total average cost of €755.10, and houses have a higher average total cost of €951.82. In 2023, both heating and lighting costs increased compared to all other years, indicating higher overall energy expenditure.

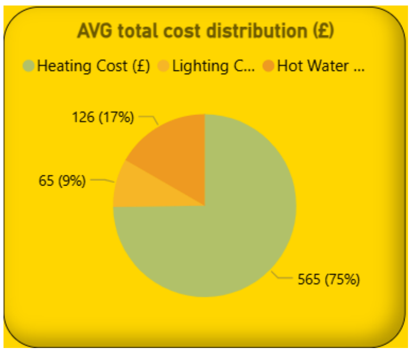


Figure 12: *Average Total Cost Distribution - Bungalows*

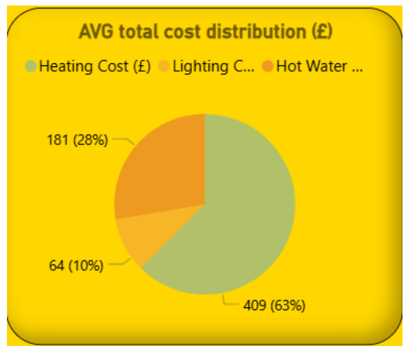


Figure 13: *Average Total Cost Distribution – Houses*

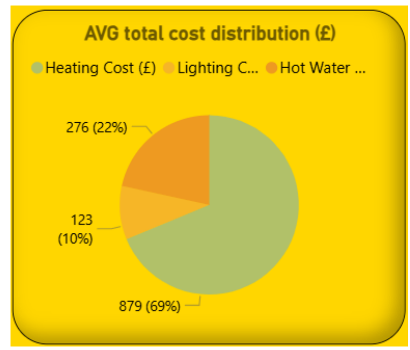


Figure 14: *Average Total Cost Distribution - 2023*

3.3.2 Heating Costs by Wall Type

Properties with Cavity wall, filled cavity construction consistently show the highest heating costs. This points out areas where insulation enhancements can result in huge savings.

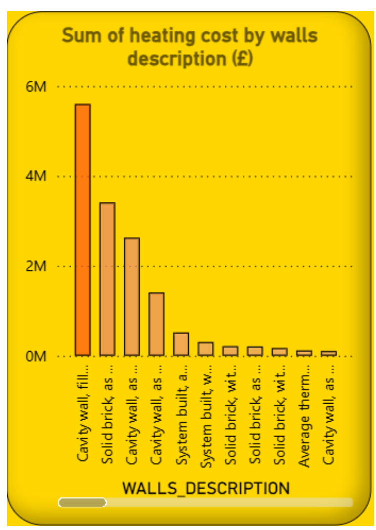


Figure 15: *Wall Type Heating Costs*

3.3.3 Lighting Costs Over Time

The price of lighting increases with time with the highest expense recorded in 2015 in Bungalow and houses and 2009 in flat. Knowledge of these time patterns aids in making plans for specific interventions.

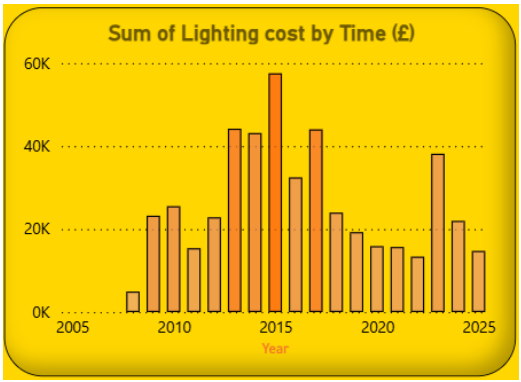


Figure 16: *Lighting Costs by Year - Bungalows*

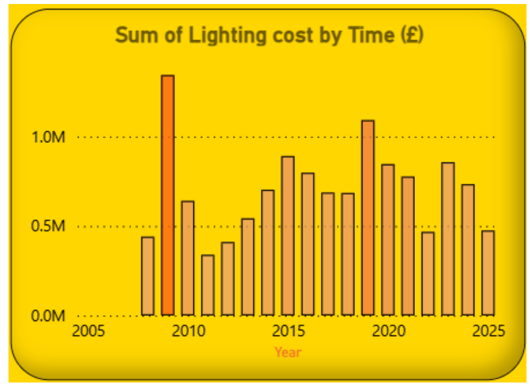


Figure 17: *Lighting Costs by Year - Flats*

3.3.4 Current and Potential Total Costs.

Comparison of area chart in Figure 18 between the current and potential total costs reveals that the recommended improvements can significantly reduce expenditure. For example, the average current heating cost of €570.45 could be decreased through targeted measures, contributing to overall savings.

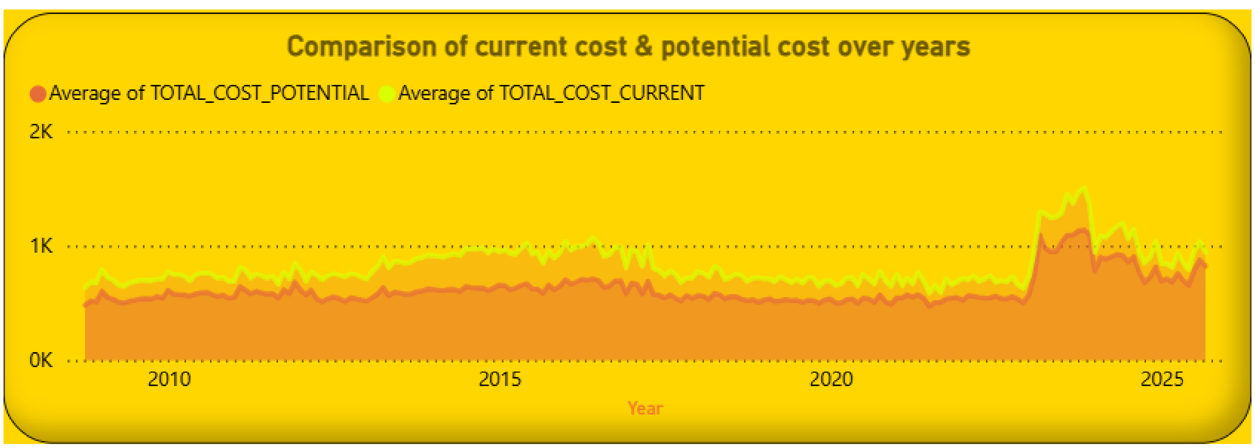


Figure 18: *Current vs Potential Total Costs Over Time*

Appendix C.4 has the entire Cost dashboard with interactive slicers.

3.4 Energy Efficiency & Recommendations Dashboard

3.4.1 CO_2 Emissions and Energy Consumption by Property Type

Energy efficiency is dependent on property type. Bungalows have an average CO^2 emission of 2.85 kg/m^2 and energy consumption of 133.64 kWh/m^2. Flats have slightly low emissions (2.41 kg/m^2) and energy consumption (188.79 kWh/m^2). The emissions of houses are 3.88 kg/m^2 and the consumption is 141.17 kWh/m^2, and the emissions and consumption of park homes and maisonettes is 3.37 - 4.80 kg/m^2 and 194.24 - 239 kWh/m^2. Energy ratings C and D dominate, showing that most properties have room for efficiency improvements.

Figure 19: CO 2 Emissions and Energy Consumption - Bungalows

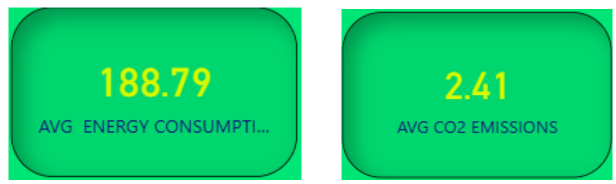


Figure 20: CO 2 Emissions and Energy Consumption – Flats

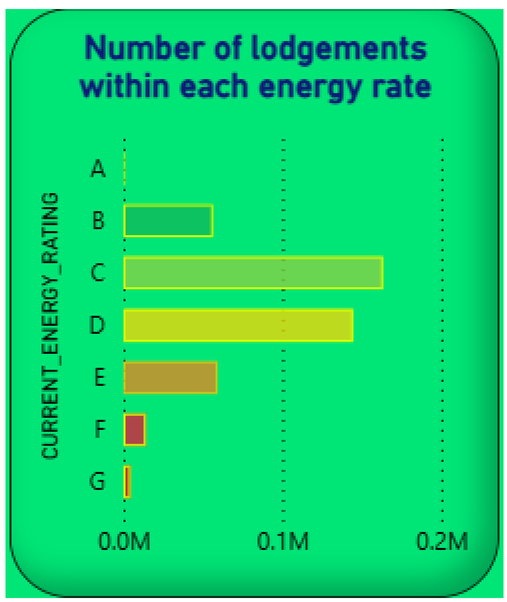


Figure 21: Number of Lodgements within each energy rate

3.4.2 Recommendations by Measure Type

The most common recommendations are based on heating and renewable energy installations. The most frequently suggested ones include solar water heating and photovoltaic panels (2.5 kWp) which suggests that they can potentially have a significant impact on environmental impact reduction.

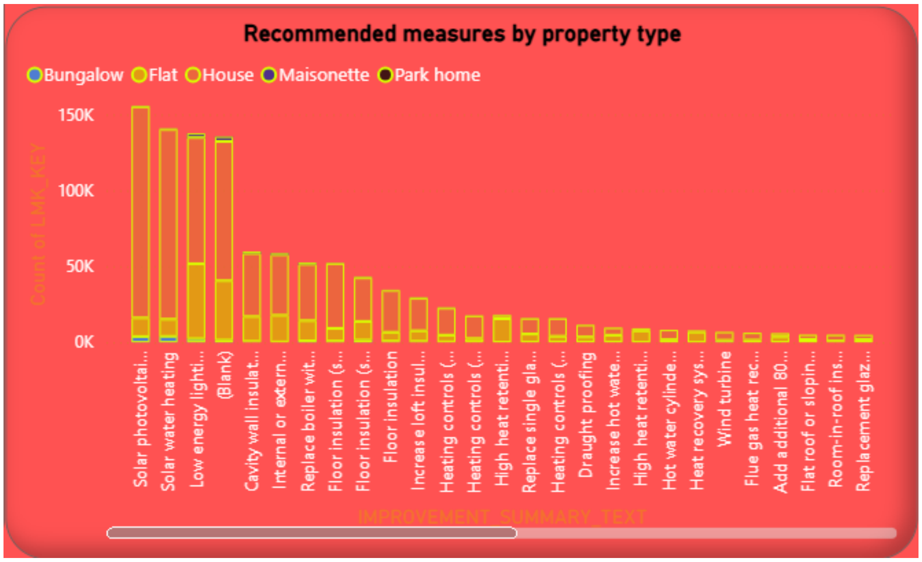


Figure 22: Recommendations by Type of Measure

3.4.3 Recommendations by Property Type

Distribution of recommended measures across property types reveals targeted opportunities. As an example, the bungalows and flats most often benefit positive effect of heating enhancement, whereas the houses and maisonettes are often offered the recommendations of renewable energy.

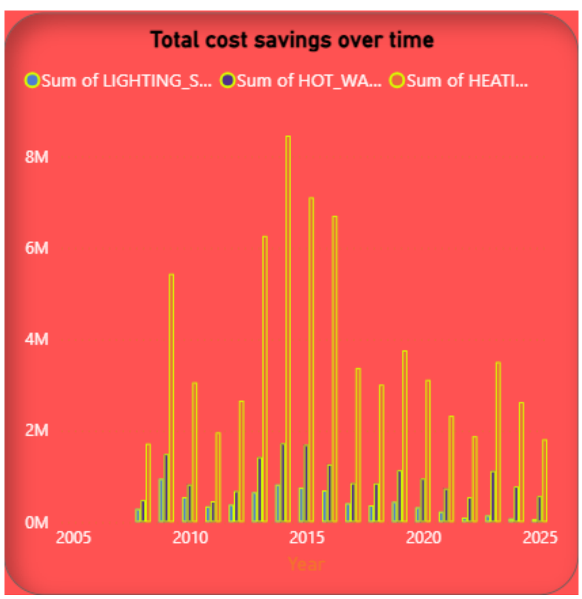


Figure 23: Property Type Recommendations

3.4.4 Number of Lodgements within Each Energy Rating

The largest lodgements are registered with the B and C rated properties, whereas those with F and G ratings are underrepresented. This indicates priority areas for efficiency upgrades.

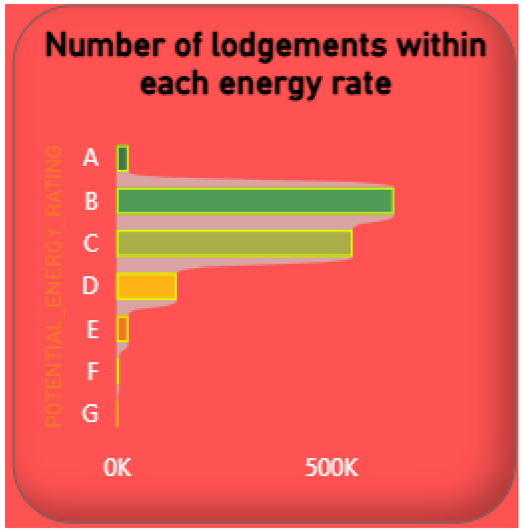


Figure 24: Number of Lodgements by Energy Rating

All slicers and interactive components of the entire Energy Efficiency and Recommendations dashboards are presented in Appendix C.5 and Appendix C.6.

4. Discussion

The Manchester EPC data shows that critical trends are present in terms of energy efficiency and improvement opportunities. The biggest part of total energy expenses is heating, which implies that retrofitting heating systems will provide the highest financial and environmental rewards. Lighting and hot water expenses are less on an individual level but add up to a large sum, bringing into focus a need to investigate the efficiency of these systems.

The Property and Building Characteristics dashboard reveals that the building stock is dominated by mid-terrace and non-community main gas properties, with the most popular measure being the loft insulation. Although simple efficiency upgrades are common, there is still significant potential in underrepresented property types. Due to the results of the inspections and energy performance, the variation in the boundary loads and roof types throughout the years occurs.

Cost analysis shows that energy expenditure is strongly associated with the features of buildings, especially types of walls and insulation. Cavity walls make properties more costly to heat, and focused retrofitting should be important. The analysis of actual and possible costs also shows the economic advantages of proposed changes, which can help stakeholders prioritize investments.

The Energy Efficiency and Recommendations dashboards show the associations between the property features and the environmental performance. Flats have a lower CO2 emissions and energy consumption than houses on average. Recommended upgrades such as the heating system and solar panel upgrades are of great financial and environmental benefit. The properties that can be most improved are distinguished by energy ratings and it is possible to concentrate on policy and interventions.

Overall, the interactive dashboards combine cost, structural, and environmental knowledge, which helps make informed, actionable decisions. With slicers, filters, and drilldowns, the stakeholders can narrow down to types of properties, periods, or areas to make sure they are relevant and useful.

5. Conclusion

This study demonstrates the value of using Power BI and SQL Server to analyze and visualize the data on the Energy Performance Certificate of the properties in Manchester. The dashboards use a combination of descriptive statistics, spatial comparison, and performance benchmarking to convey information on energy efficiency, costs, CO2 emissions, and recommend some improvements. Key conclusions include:

1. The major cost driver is heating, which means that heating system interventions are likely to have the greatest level of savings.

2. The characteristic features have a considerable impact on the performance of the energy, as the mid-terrace properties, cavity walls, and particular roof types have different costs and emissions.

3. The potential improvements have definite environmental and financial advantages as seen in the discrepancies between the current and potential scores of energy efficiency, costs and emissions.

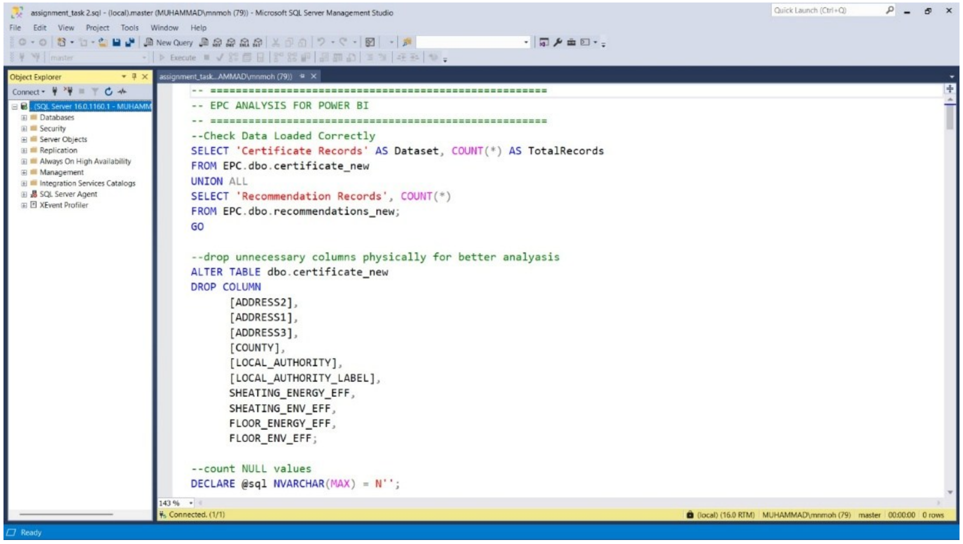
4. Solar panel installations and heating upgrades are among the recommendations suggesting feasible ways of reducing the cost as well as the carbon emissions.

5. Interactive dashboards can improve the decision-making process of the stakeholders as they can explore by property type, tenure, energy rating, and geographic area to facilitate policy development and interventions.

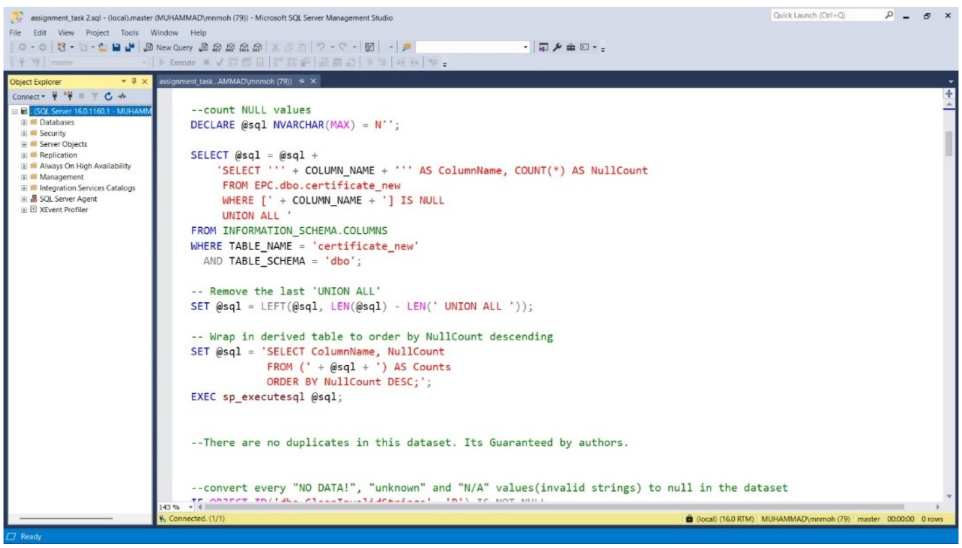
In conclusion, this analysis shows the areas in which the energy efficiency initiatives can be the priority in Manchester and offers a replicable framework to be used in the assessment of similar areas in different regions. The combination of SQL Server to manage data and Power BI to visualize it will make the findings robust and accessible, allowing policy makers, property owners and sustainability stakeholders to make evidence-based decisions.

6. Appendices

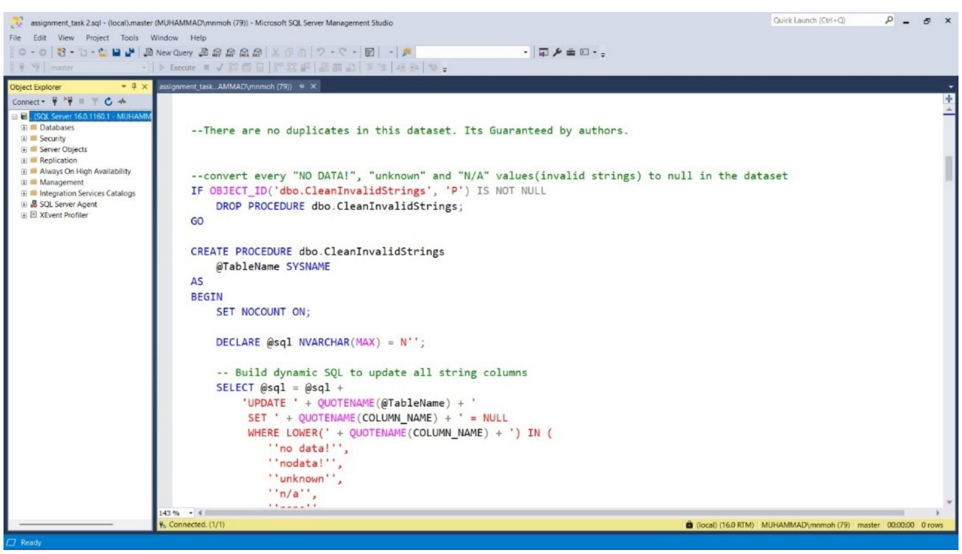
Appendix A: SQL Scripts for Data Preparation and Views



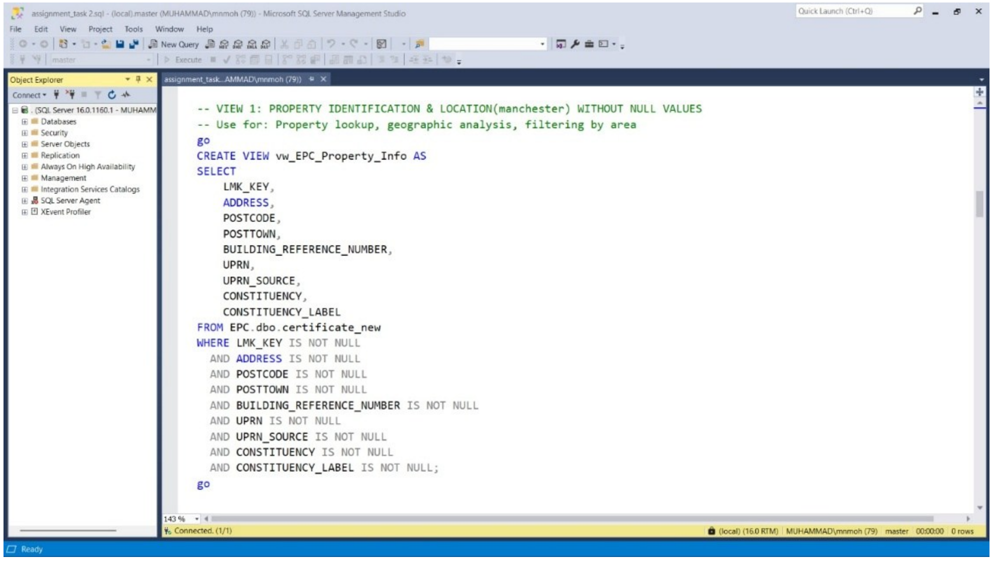
```sql
-- =====================================================
-- EPC ANALYSIS FOR POWER BI
-- =====================================================
--Check Data Loaded Correctly
SELECT 'Certificate Records' AS Dataset, COUNT(*) AS TotalRecords
FROM EPC.dbo.certificate_new
UNION ALL
SELECT 'Recommendation Records', COUNT(*)
FROM EPC.dbo.recommendations_new;
GO

--drop unnecessary columns physically for better analaysis
ALTER TABLE dbo.certificate_new
DROP COLUMN
      [ADDRESS2],
      [ADDRESS1],
      [ADDRESS3],
      [COUNTY],
      [LOCAL_AUTHORITY],
      [LOCAL_AUTHORITY_LABEL],
      SHEATING_ENERGY_EFF,
      SHEATING_ENV_EFF,
      FLOOR_ENERGY_EFF,
      FLOOR_ENV_EFF;

--count NULL values
DECLARE @sql NVARCHAR(MAX) = N'';
```



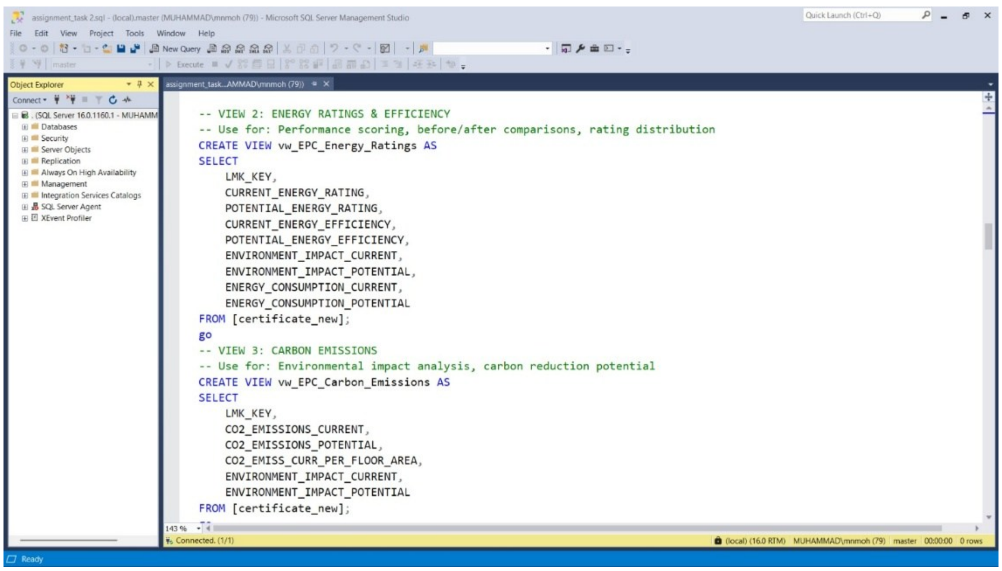
```sql
--count NULL values
DECLARE @sql NVARCHAR(MAX) = N'';

SELECT @sql = @sql +
    'SELECT ''' + COLUMN_NAME + ''' AS ColumnName, COUNT(*) AS NullCount
     FROM EPC.dbo.certificate_new
     WHERE [' + COLUMN_NAME + '] IS NULL
     UNION ALL '
FROM INFORMATION_SCHEMA.COLUMNS
WHERE TABLE_NAME = 'certificate_new'
  AND TABLE_SCHEMA = 'dbo';

-- Remove the last 'UNION ALL'
SET @sql = LEFT(@sql, LEN(@sql) - LEN(' UNION ALL '));

-- Wrap in derived table to order by NullCount descending
SET @sql = 'SELECT ColumnName, NullCount
            FROM (' + @sql + ') AS Counts
            ORDER BY NullCount DESC;';
EXEC sp_executesql @sql;


--There are no duplicates in this dataset. Its Guaranteed by authors.


--convert every "NO DATA!", "unknown" and "N/A" values(invalid strings) to null in the dataset
```



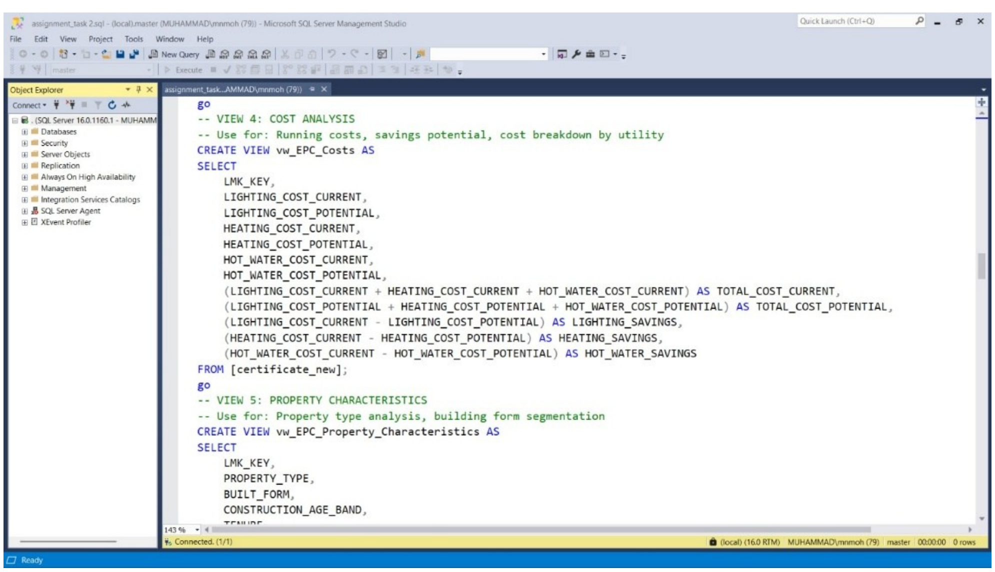
```sql
--There are no duplicates in this dataset. Its Guaranteed by authors.


--convert every "NO DATA!", "unknown" and "N/A" values(invalid strings) to null in the dataset
IF OBJECT_ID('dbo.CleanInvalidStrings', 'P') IS NOT NULL
    DROP PROCEDURE dbo.CleanInvalidStrings;
GO

CREATE PROCEDURE dbo.CleanInvalidStrings
    @TableName SYSNAME
AS
BEGIN
    SET NOCOUNT ON;

    DECLARE @sql NVARCHAR(MAX) = N'';

    -- Build dynamic SQL to update all string columns
    SELECT @sql = @sql +
        'UPDATE ' + QUOTENAME(@TableName) + '
         SET ' + QUOTENAME(COLUMN_NAME) + ' = NULL
         WHERE LOWER(' + QUOTENAME(COLUMN_NAME) + ') IN (
            ''no data!'',
            ''nodata!'',
            ''unknown'',
            ''n/a'',
```



```sql
-- VIEW 1: PROPERTY IDENTIFICATION & LOCATION(manchester) WITHOUT NULL VALUES
-- Use for: Property lookup, geographic analysis, filtering by area
go
CREATE VIEW vw_EPC_Property_Info AS
SELECT
    LMK_KEY,
    ADDRESS,
    POSTCODE,
    POSTTOWN,
    BUILDING_REFERENCE_NUMBER,
    UPRN,
    UPRN_SOURCE,
    CONSTITUENCY,
    CONSTITUENCY_LABEL
FROM EPC.dbo.certificate_new
WHERE LMK_KEY IS NOT NULL
  AND ADDRESS IS NOT NULL
  AND POSTCODE IS NOT NULL
  AND POSTTOWN IS NOT NULL
  AND BUILDING_REFERENCE_NUMBER IS NOT NULL
  AND UPRN IS NOT NULL
  AND UPRN_SOURCE IS NOT NULL
  AND CONSTITUENCY IS NOT NULL
  AND CONSTITUENCY_LABEL IS NOT NULL;
go
```



```sql
-- VIEW 2: ENERGY RATINGS & EFFICIENCY
-- Use for: Performance scoring, before/after comparisons, rating distribution
CREATE VIEW vw_EPC_Energy_Ratings AS
SELECT
    LMK_KEY,
    CURRENT_ENERGY_RATING,
    POTENTIAL_ENERGY_RATING,
    CURRENT_ENERGY_EFFICIENCY,
    POTENTIAL_ENERGY_EFFICIENCY,
    ENVIRONMENT_IMPACT_CURRENT,
    ENVIRONMENT_IMPACT_POTENTIAL,
    ENERGY_CONSUMPTION_CURRENT,
    ENERGY_CONSUMPTION_POTENTIAL
FROM [certificate_new];
go
-- VIEW 3: CARBON EMISSIONS
-- Use for: Environmental impact analysis, carbon reduction potential
CREATE VIEW vw_EPC_Carbon_Emissions AS
SELECT
    LMK_KEY,
    CO2_EMISSIONS_CURRENT,
    CO2_EMISSIONS_POTENTIAL,
    CO2_EMISS_CURR_PER_FLOOR_AREA,
    ENVIRONMENT_IMPACT_CURRENT,
    ENVIRONMENT_IMPACT_POTENTIAL
FROM [certificate_new];
```



```sql
go
-- VIEW 4: COST ANALYSIS
-- Use for: Running costs, savings potential, cost breakdown by utility
CREATE VIEW vw_EPC_Costs AS
SELECT
    LMK_KEY,
    LIGHTING_COST_CURRENT,
    LIGHTING_COST_POTENTIAL,
    HEATING_COST_CURRENT,
    HEATING_COST_POTENTIAL,
    HOT_WATER_COST_CURRENT,
    HOT_WATER_COST_POTENTIAL,
    (LIGHTING_COST_CURRENT + HEATING_COST_CURRENT + HOT_WATER_COST_CURRENT) AS TOTAL_COST_CURRENT,
    (LIGHTING_COST_POTENTIAL + HEATING_COST_POTENTIAL + HOT_WATER_COST_POTENTIAL) AS TOTAL_COST_POTENTIAL,
    (LIGHTING_COST_CURRENT - LIGHTING_COST_POTENTIAL) AS LIGHTING_SAVINGS,
    (HEATING_COST_CURRENT - HEATING_COST_POTENTIAL) AS HEATING_SAVINGS,
    (HOT_WATER_COST_CURRENT - HOT_WATER_COST_POTENTIAL) AS HOT_WATER_SAVINGS
FROM [certificate_new];
go
-- VIEW 5: PROPERTY CHARACTERISTICS
-- Use for: Property type analysis, building form segmentation
CREATE VIEW vw_EPC_Property_Characteristics AS
SELECT
    LMK_KEY,
    PROPERTY_TYPE,
    BUILT_FORM,
    CONSTRUCTION_AGE_BAND,
```

Appendix B: DAX Measures for Power BI

Total Certificates

```
Total Certificates = COUNT('certificate_new'[LMK_KEY])
```

Certificates per Year

```
Certificates Per Year =
CALCULATE(
    COUNT('certificate_new'[LMK_KEY]),
    VALUES('vw_EPC_Admin'[INSPECTION_DATE].[Year])
)
```

Total Recommendations

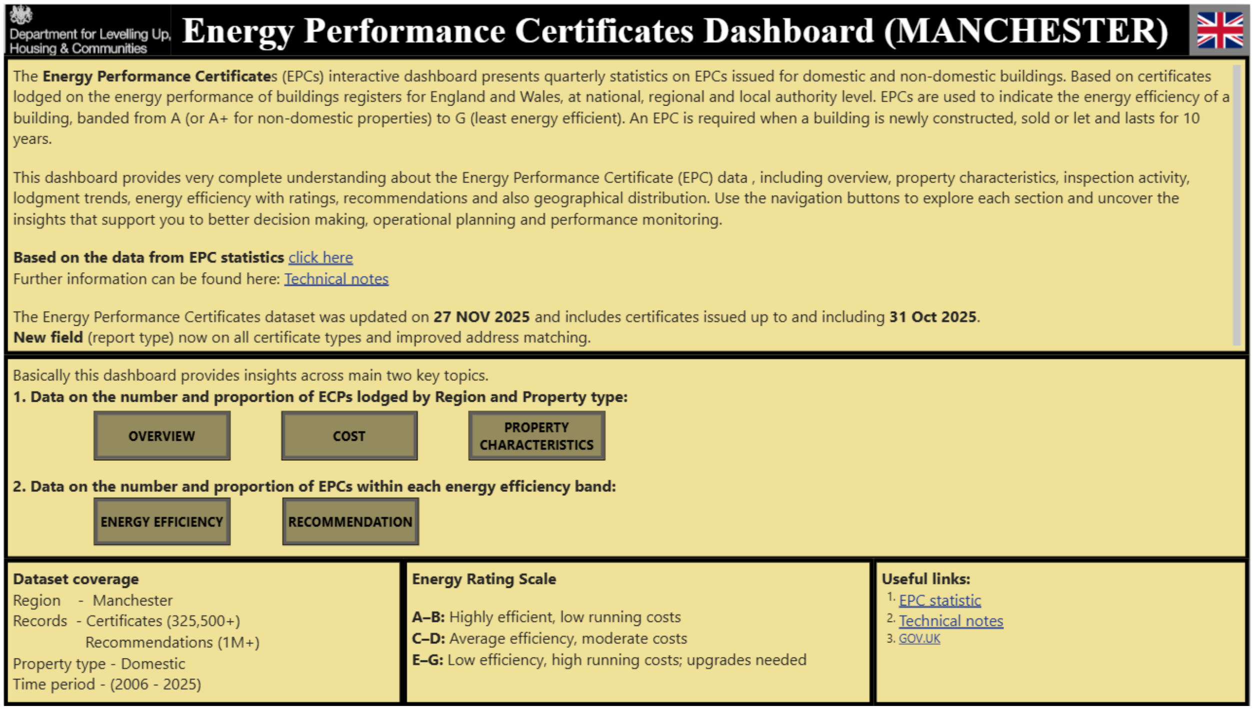
```
Total Recommendations = COUNT('recommendations_new'[LMK_KEY])
```

Test Count

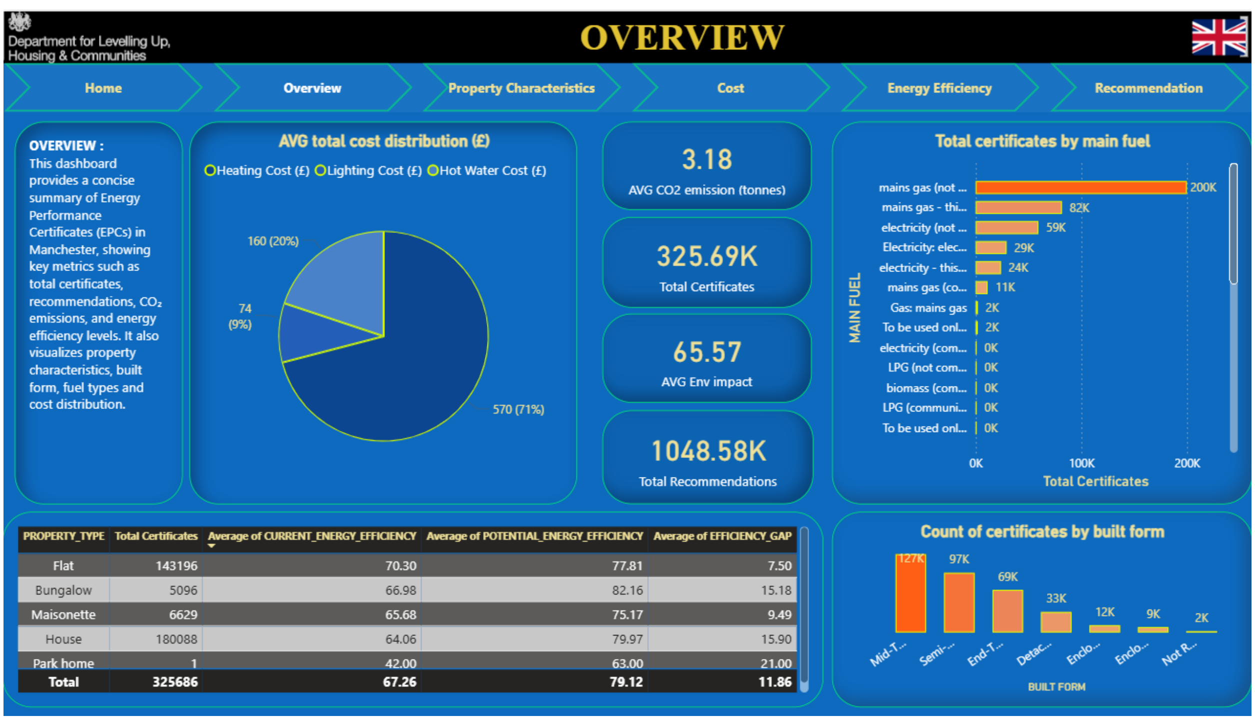
```
TestCount =
COUNTROWS('certificate_new')
```

Appendix C: Dashboard Tabs and Visuals

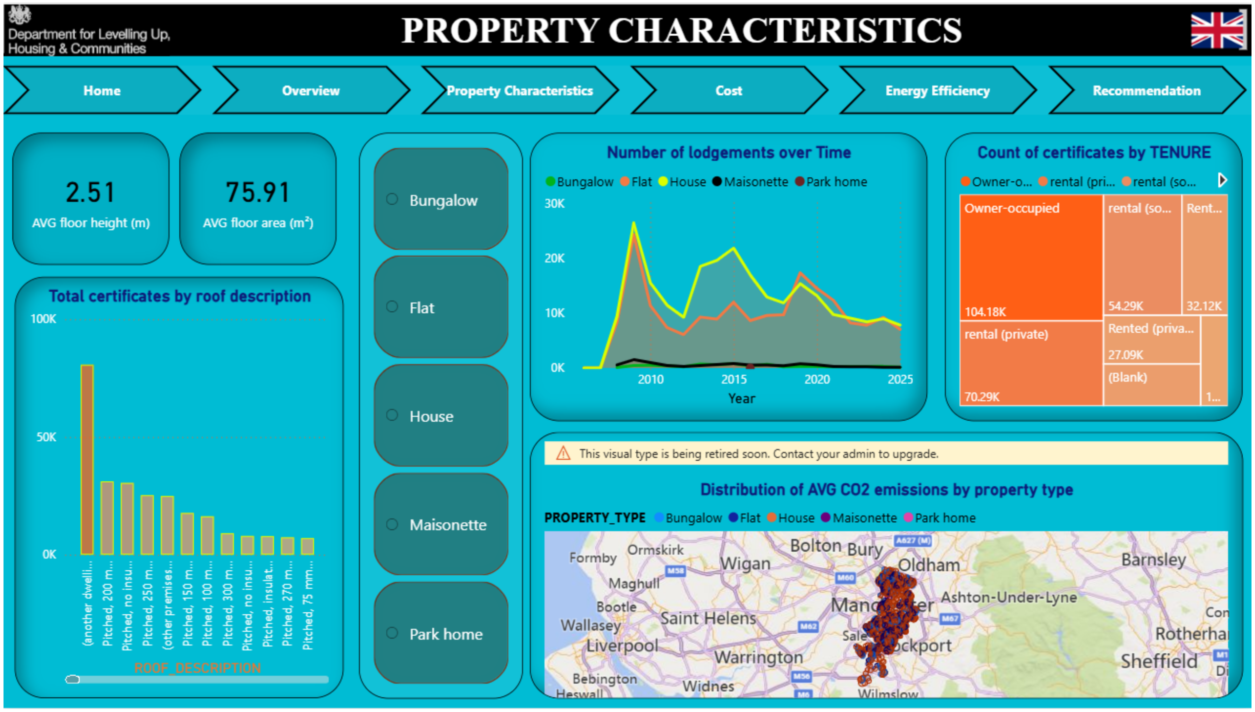
C.1 Home Screen



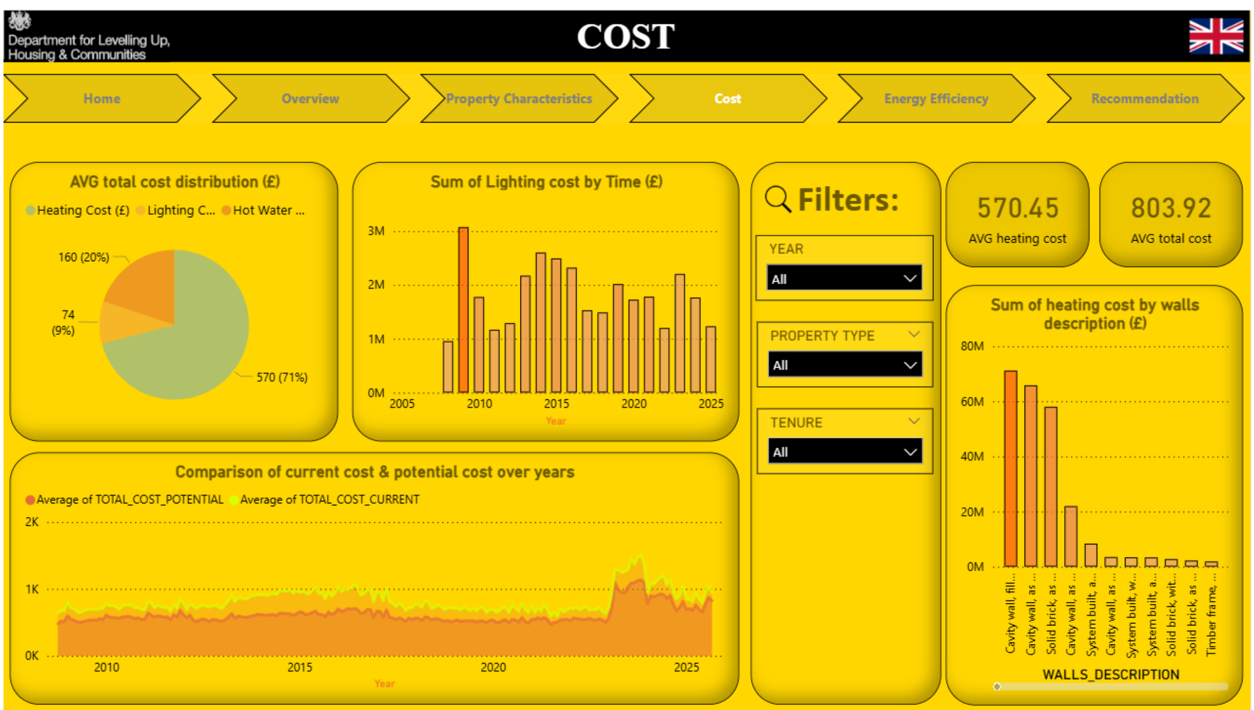
C.2 Overview Dashboard



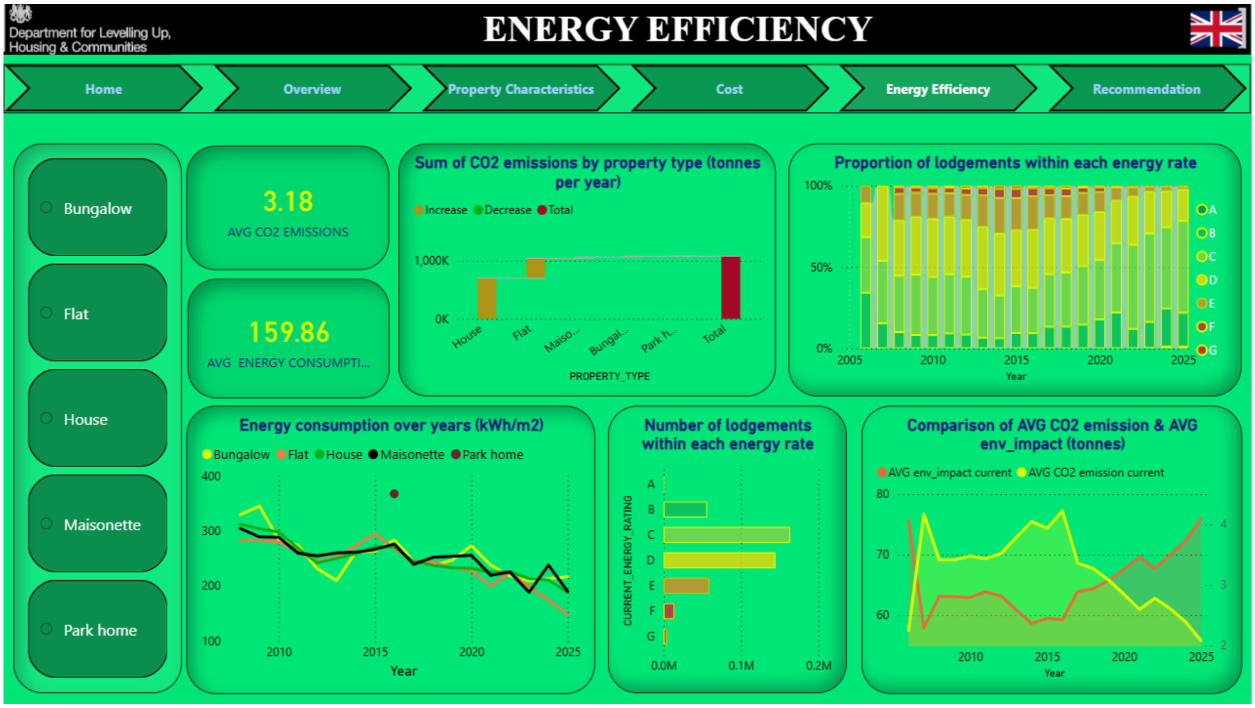
C.3 Property Characteristics Dashboard



C.4 Cost Dashboard



C.5 Energy Efficiency Dashboard



C.6 Recommendation Dashboard