

Task 02:

“Greater Manchester Energy Performance Trends: Analysing Domestic Energy Certificates (2013-2023)”

2.1 Introduction

Energy efficiency is a critical focus in addressing global climate change and reducing carbon emissions. In the United Kingdom, Energy Performance Certificates (EPCs) have become a key tool for assessing the energy efficiency of both residential and commercial buildings. These certificates provide a rating system, ranging from A (most efficient) to G (least efficient), and offer recommendations for improving a building's energy performance. The data collected through EPCs is essential for informing homeowners, landlords, property buyers, and policymakers about energy efficiency standards and potential upgrades that can reduce energy costs and environmental impact.

This report presents an analysis of Energy Performance Certificate (EPC) data for the local authorities within Greater Manchester, spanning the period from 2013 to 2023. The analysis is designed to explore trends in energy efficiency, emissions, and energy use across various property types and geographical locations. The study aims to generate actionable insights for stakeholders in the energy sector, helping them understand current energy performance trends and identify areas for improvement to achieve future energy efficiency targets.

Using Power BI, this project transforms raw EPC data into an interactive and visually appealing dashboard, enabling stakeholders to filter and explore the data in meaningful ways. The report also details the data cleaning, transformation, and modelling processes, and investigates key relationships between variables such as property type, energy rating, and geographical location.

2.2 Exploring the Dataset

The dataset used for this analysis contains Energy Performance Certificate (EPC) data for properties across Manchester's local authorities, covering the period from 2013 to 2023. An EPC provides an assessment of a building's energy efficiency, giving it a rating from A (most efficient) to G (least efficient). The dataset offers detailed information on the current and potential energy ratings of each property, CO2 emissions, energy consumption levels, and associated costs for lighting, heating, and hot water. It also includes property-specific details such as the type of building (e.g., house, flat), construction age, total floor area, and whether the property has access to mains gas. Key timestamps, such as inspection and lodgement dates, as well as transaction types (sale, rent, or new construction), provide temporal context for the data. This dataset serves as a valuable resource for stakeholders including homeowners, landlords, tenants, policymakers, and energy consultants to monitor energy efficiency trends, assess the impact of improvement efforts, and identify areas that require further intervention to meet carbon reduction targets. Additionally, it supports the development of energy-related policies by providing a comprehensive view of the energy performance landscape in the region.

□ Property and Location Details:

- POSTCODE: Postal code of the property.
- BUILDING_REFERENCE_NUMBER: Unique identifier for each building.
- PROPERTY_TYPE: Type of property (e.g., house, apartment).
- BUILT_FORM: Structural form of the building (e.g., detached, semi-detached).
- ADDRESS, POSTTOWN, LOCAL_AUTHORITY_LABEL, CONSTITUENCY_LABEL: Location details of the property.
- LOCAL_AUTHORITY, CONSTITUENCY, COUNTY: Administrative divisions.

• Energy Ratings and Efficiency:

- CURRENT_ENERGY_RATING / POTENTIAL_ENERGY_RATING: Current and potential energy performance.
- CURRENT_ENERGY_EFFICIENCY / POTENTIAL_ENERGY_EFFICIENCY: Energy efficiency scores.
- ENVIRONMENT_IMPACT_CURRENT / ENVIRONMENT_IMPACT_POTENTIAL: Current and potential environmental impact scores.
- ENERGY_CONSUMPTION_CURRENT / ENERGY_CONSUMPTION_POTENTIAL: Energy consumption values.

• CO2 Emissions and Costs:

- CO2_EMISSIONS_CURRENT / CO2_EMISSIONS_POTENTIAL: CO2 emissions figures.
- LIGHTING_COST_CURRENT / LIGHTING_COST_POTENTIAL: Lighting costs.
- HEATING_COST_CURRENT / HEATING_COST_POTENTIAL: Heating costs.
- HOT_WATER_COST_CURRENT / HOT_WATER_COST_POTENTIAL: Hot water costs.

- **Building Features:**

- FLOOR_LEVEL, TOTAL_FLOOR_AREA: Physical characteristics of the building.
- MAIN_HEATING_CONTROLS, MAIN_FUEL: Heating system details.
- GLAZED_TYPE, GLAZED_AREA: Window and glazing details.
- HOTWATER_DESCRIPTION: Hot water system description.

- **Energy and Environmental Performance:**


- Multiple energy efficiency columns (e.g., WALLS_ENERGY_EFF, ROOF_ENERGY_EFF) covering different building elements (e.g., walls, windows, floors).
- MAINHEAT_ENV_EFF, LIGHTING_ENV_EFF: Environmental performance metrics.

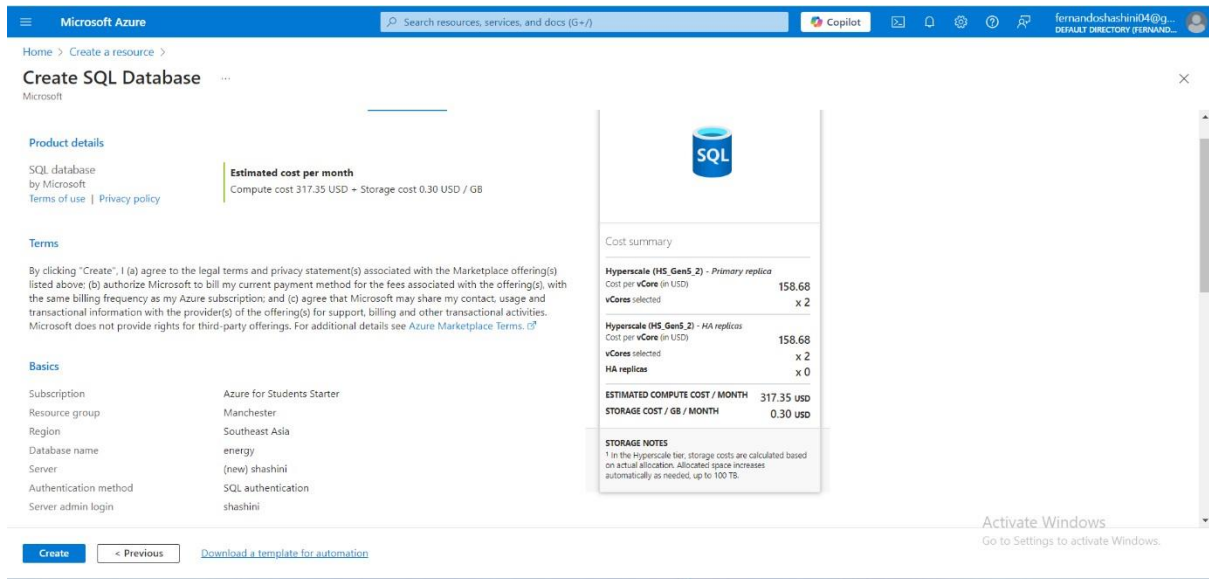
- **Other Details:**

- TRANSACTION_TYPE: Type of transaction (e.g., sale, rental).
- INSPECTION_DATE, LODGEMENT_DATE: Inspection and submission dates.
- MECHANICAL_VENTILATION, WIND_TURBINE_COUNT: Details on additional energysaving features.
- TENURE: Ownership type (e.g., freehold, leasehold).
- CONSTRUCTION_AGE_BAND: Age band of the building.

2.3 Data Base design, Data Cleaning and Transformation

- **Data Base Design**

 We utilized an **Azure SQL Database** to store and manage the Energy Performance Certificate (EPC) data for Manchester's local authorities.

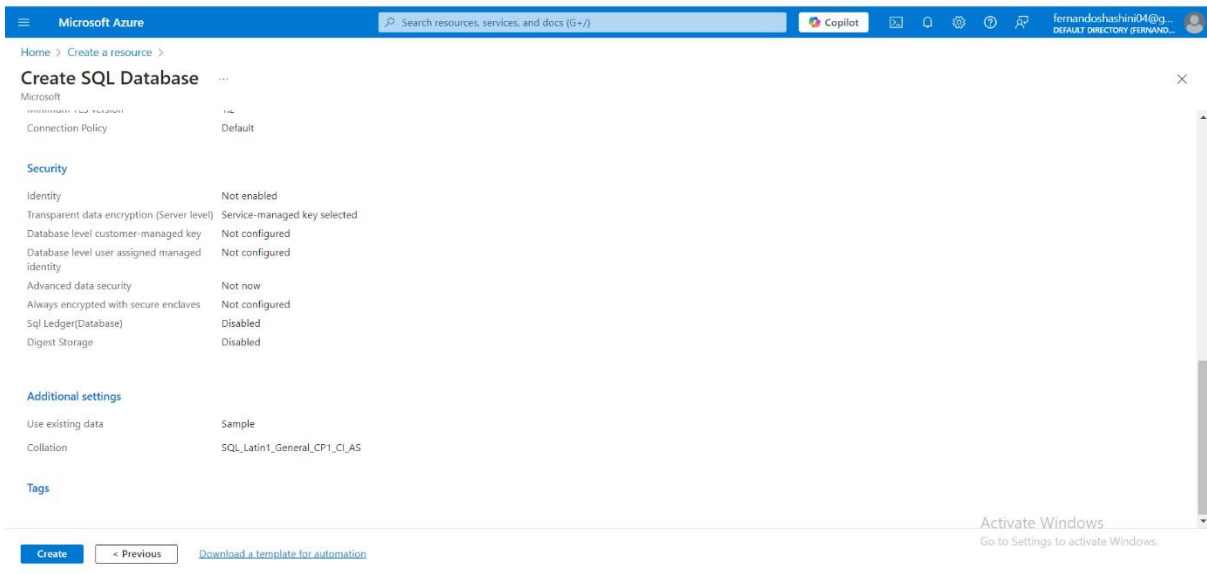


The screenshot shows the 'Create SQL Database' wizard in the Microsoft Azure portal, specifically the 'Basics' tab. The interface includes a top navigation bar with the Azure logo, a search bar, and user information. The main content area is divided into sections: 'Product details', 'Terms', and 'Basics'. The 'Basics' section contains configuration details for the SQL database, including subscription, resource group, region, database name, server, authentication method, and server admin login. A 'Cost summary' panel on the right provides a breakdown of costs, including compute and storage costs per month. At the bottom, there are buttons for 'Create', '< Previous', and 'Download a template for automation', along with an 'Activate Windows' watermark.

Subscription	Azure for Students Starter
Resource group	Manchester
Region	Southeast Asia
Database name	energy
Server	(new) shashini
Authentication method	SQL authentication
Server admin login	shashini

Cost summary	
Hyperscale (HS_Gen5_2) - Primary replica	
Cost per vCore (in USD)	158.68
vCores selected	x 2
Hyperscale (HS_Gen5_2) - HA replicas	
Cost per vCore (in USD)	158.68
vCores selected	x 2
HA replicas	x 0
ESTIMATED COMPUTE COST / MONTH	317.35 USD
STORAGE COST / GB / MONTH	0.30 USD

STORAGE NOTES
1 In the Hyperscale tier, storage costs are calculated based on actual allocation. Allocated space increases automatically as needed, up to 100 TB.

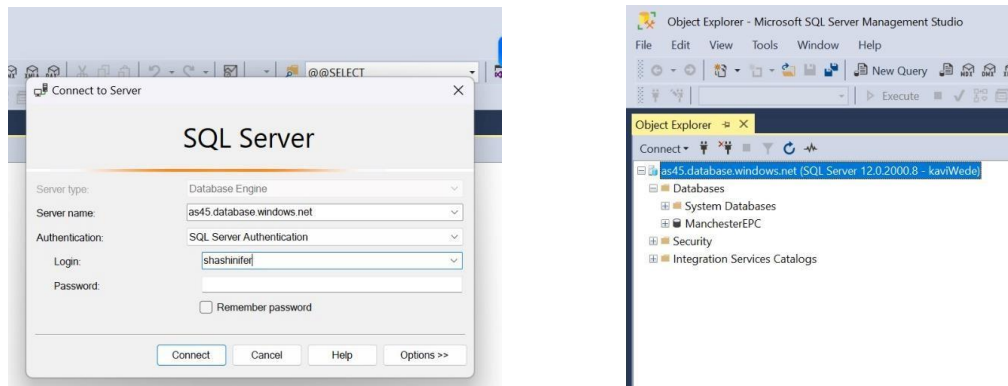


The screenshot shows the 'Create SQL Database' wizard in the Microsoft Azure portal, specifically the 'Security' tab. The interface includes a top navigation bar with the Azure logo, a search bar, and user information. The main content area is divided into sections: 'Security' and 'Additional settings'. The 'Security' section contains configuration details for security features, including identity, transparent data encryption, database level user assigned managed identity, advanced data security, always encrypted with secure enclaves, SQL Ledger, and digest storage. The 'Additional settings' section contains configuration details for use existing data and collation. At the bottom, there are buttons for 'Create', '< Previous', and 'Download a template for automation', along with an 'Activate Windows' watermark.

Identity	Not enabled
Transparent data encryption (Server level)	Service-managed key selected
Database level customer-managed key	Not configured
Database level user assigned managed identity	Not configured
Advanced data security	Not now
Always encrypted with secure enclaves	Not configured
Sql Ledger(Database)	Disabled
Digest Storage	Disabled

Use existing data	Sample
Collation	SQL_Latin1_General_CP1_CI_AS

- After connecting the Azure SQL Database to SQL Server, I was able to manage and interact with the cloud-based database using familiar SQL Server Management Studio (SSMS) tools.

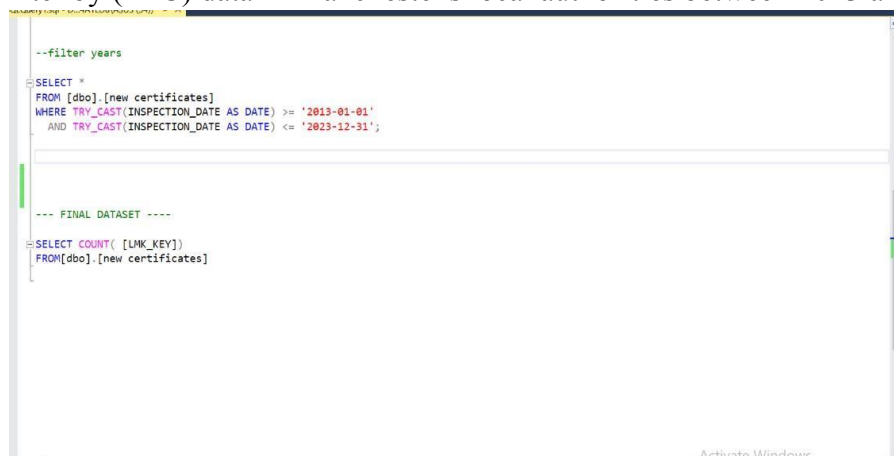


- Data Cleaning Process**

1. Checking and Removing Duplicates



- 2.Filter by (EPC) data in Manchester's local authorities between 2013 and 2023.



2.4 Creating Views Using DAX in Power BI

To enhance the analysis of the Energy Performance Certificate (EPC) data, we utilized **Data Analysis Expressions (DAX)** to create calculated views directly within Power BI. DAX allowed us to define custom measures, calculated columns, and tables that supported in-depth analysis of key metrics like energy efficiency ratings, CO2 emissions, and property type distributions.

```
1 Average Rating by Local Authority =  
2 AVERAGEX(  
3     VALUES('CLEAN CERTIFICATE'[LOCAL_AUTHORITY]),  
4     CALCULATE(AVERAGE('CLEAN CERTIFICATE'[CURRENT_ENERGY_RATING]))  
5 )  
6
```

```
1 Average Energy Efficiency =  
2 AVERAGE('CLEAN CERTIFICATE'[CURRENT_ENERGY_EFFICIENCY])
```

```
1 Avg CO2 Emissions = AVERAGE('CLEAN CERTIFICATE'[CO2_EMISSIONS_CURRENT])
```

```
1 Average Floor Area =  
2 AVERAGE('CLEAN CERTIFICATE'[FLOOR_LEVEL])  
3
```

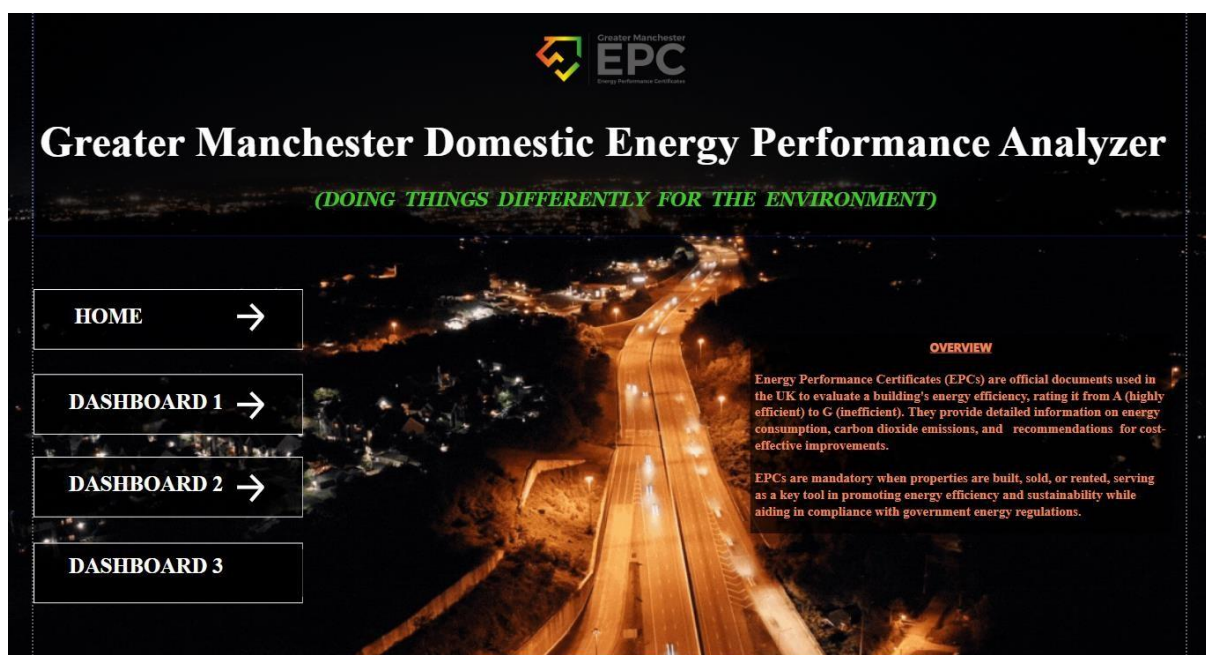
```
Number of Properties = DISTINCTCOUNT('CLEAN CERTIFICATE'[PROPERTY_TYPE])
```

```
1 Avg Energy Rating = AVERAGE('CLEAN CERTIFICATE'[CURRENT_ENERGY_RATING])
```

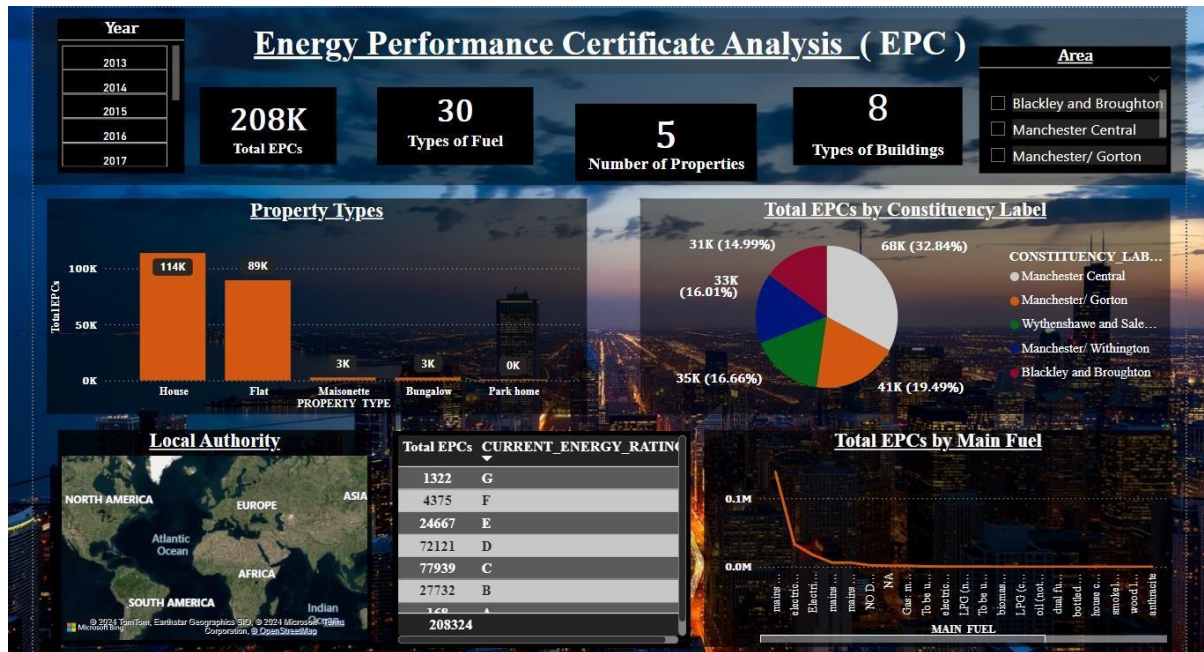
2.5 Dashboard Design

We created a Power BI dashboard to analyse and visualize Energy Performance Certificate (EPC) data for Manchester's local authorities from 2013 to 2023. The dashboard includes key metrics such as energy ratings, CO2 emissions, and property types. It features interactive visualizations like bar charts, maps, and slicers to explore energy performance trends, allowing stakeholders to filter by year, local authority, and property type. The dashboard provides valuable insights into energy efficiency, helping users make informed decisions about improving energy performance in different regions.

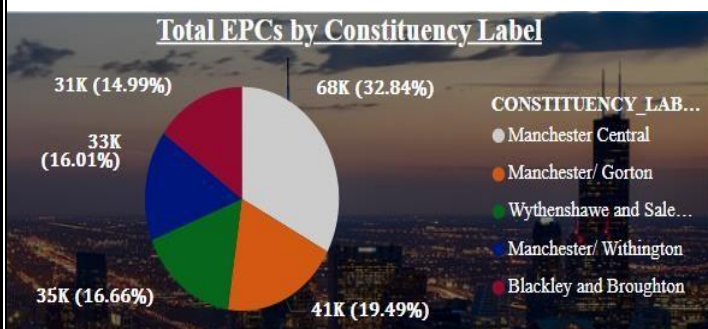
1st Page-----Home Page



The **Home page** of the Greater Manchester Domestic Energy Performance Analyzer dashboard serves as an introduction and navigation hub. The page includes navigation buttons leading to different dashboard sections and an overview of **Energy Performance Certificates (EPCs)**, explaining their role in assessing building energy efficiency and promoting sustainability. The clean design and user-friendly layout make it easy for stakeholders to access key insights and data visualizations.



The **EPC Analysis** dashboard provides a comprehensive view of Energy Performance Certificates (EPC) data for Greater Manchester. It features key metrics such as the total number of EPCs (208K), types of fuel, buildings, and properties. Visualizations include a bar chart for property types, a pie chart for EPC distribution by constituency, and a table showing EPCs by energy rating. Filters for year and area allow users to explore the data in greater detail. Additionally, the dashboard incorporates a map highlighting local authorities and a chart showing EPCs by main fuel type, offering stakeholders a thorough analysis of energy performance across the region.



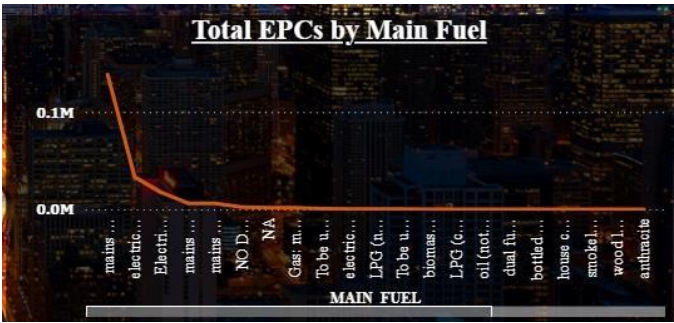
The pie chart showing the distribution of Energy Performance Certificates (EPCs) across different constituencies.



The Map showing Local Authority. It use to placing all major landmasses in one frame, it allows for easy comparison between regions in terms of size, proximity, and geographic features.

Total EPCs	CURRENT_ENERGY_RATING
1322	G
4375	F
24667	E
72121	D
77939	C
27732	B
168	A
208324	

The table describe Total EPCs with the current energy ratings. It used to easily understand details for our analysis.



The line chart shows total EPCs by Main fuel.X axis shows main fuel and Y axis shows number of total EPCs. It is ideal for tracking how data changes over fuels.



The dashboard titled **"Energy Insights and Trends"** provides an overview of CO2 emissions and energy efficiency across different property types and constituencies. It highlights the average energy efficiency score, CO2 emission counts, and distribution of emissions by constituency. Key elements include a pie chart showing CO2 emissions by region, a table detailing property types and local authority emissions, and bar charts comparing energy ratings across property types. The dashboard offers valuable insights for monitoring energy performance and identifying areas for reducing emissions.

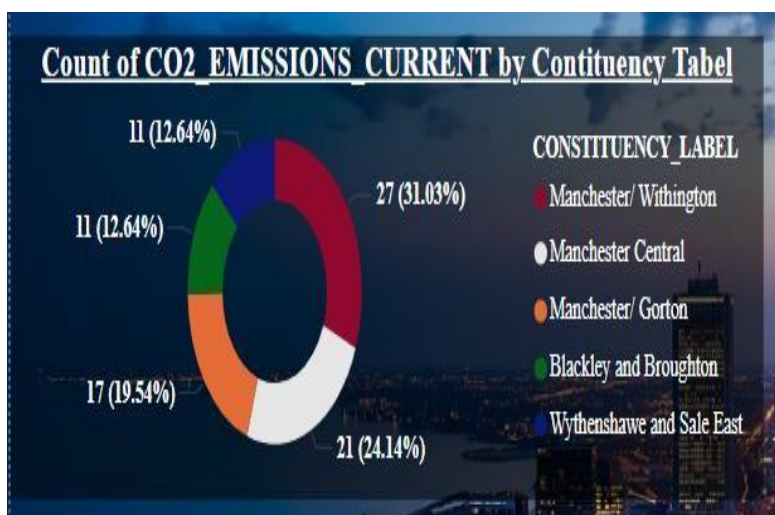


CONSTITUENCY_LABEL	PROPERTY_TYPE	LOCAL_AUTHORITY_LABEL	Sum of Co2 Emission Current
Blackley and Broughton	Bungalow	Manchester	
Blackley and Broughton	Flat	Manchester	
Blackley and Broughton	House	Manchester	3
Manchester Central	Bungalow	Manchester	
Manchester Central	Flat	Manchester	25
Manchester Central	House	Manchester	25
Total			1,09

Constituency Label and Property Type Table

A table displaying the list of properties by:

- Constituency (e.g., Blackley and Broughton, Manchester Central)
- Property Type (Bungalow, Flat, House)
- Local Authority (Manchester)
- Sum of CO2 Emission: Numeric values showing emission count for each property.



Pie Chart of CO2 Emissions by Constituency

The pie chart displays the distribution of CO2 emissions across various constituencies:

Manchester/Withington: 12.64%

Manchester Central: 31.03%

Manchester/Gorton: 19.54%

Blackley and Broughton: 24.14%



A horizontal bar chart showing energy ratings for different property types:

- **Flat:** Approx. 505 units
- **House:** Approx. 504 units
- **Bungalow:** Slightly less than 100 units
- **Maisonette:** Very few



A histogram showing the count of property types along the X-axis for various levels of CO2 emissions (represented by categories like 1, 2, 3, 4, etc.)

4th Page-----Dashboard 03

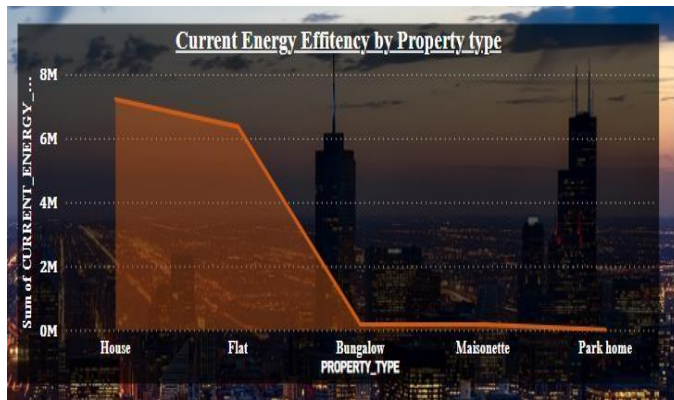


The **Energy Efficiency Overview** dashboard presents key insights into energy performance across various property types and regions. It highlights the total hot water cost (24M) and CO2 emissions (9M), along with energy efficiency distribution by property types like houses, across various property types and regions. It highlights the total hot water cost (24M) and flats, and bungalows. The dashboard also shows fuel types used, energy efficiency trends CO2 emissions (9M), along with energy efficiency distribution by property types like houses, from 2014 to 2022, and efficiency breakdowns flats, and bungalows. The dashboard also shows fuel types used, energy efficiency trends s by constituency, with Manchester Central accounting for the largest share. A postcode map visually pinpoints areas of energy usage, from 2014 to 2022, and efficiency breakdowns by constituency, with Manchester Central providing a detailed overview for optimizing energy consumption and reducing emissions.



Sum of Hot Water Cost & CO2 Current

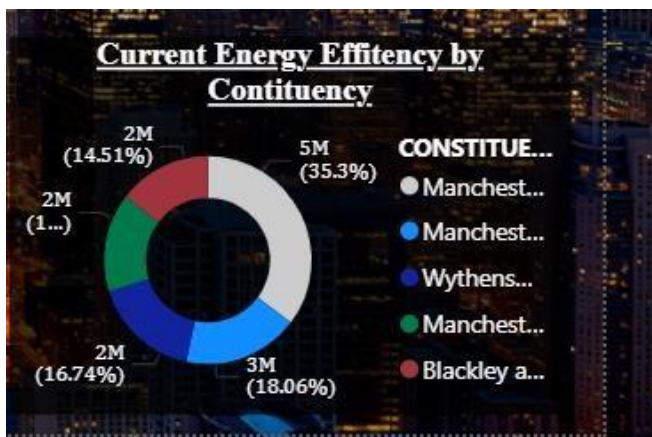
- Single Metric Boxes:
 - The Hot Water Cost is shown as 24M.
 - The CO2 Current Emissions are summed at 9M.
- These highlight key figures related to energy and emissions costs.



Current Energy Efficiency by Property Type

A line chart showing the sum of current energy efficiency for different property types:

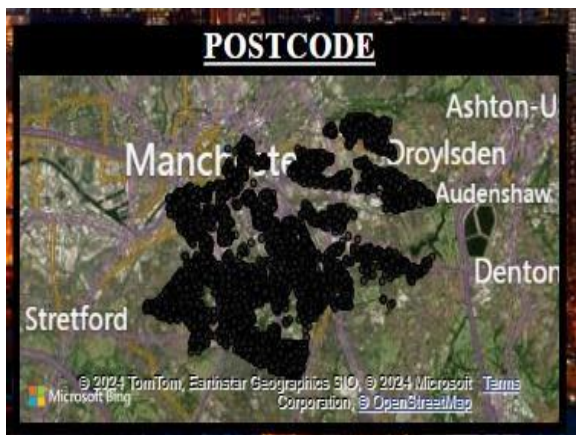
- House: Highest energy efficiency (~8M units)
- Flat: Significant drop (~2M units)
- Bungalow, Maisonette, and Park Home: Minimal values near zero.



Current Energy Efficiency by Constituency

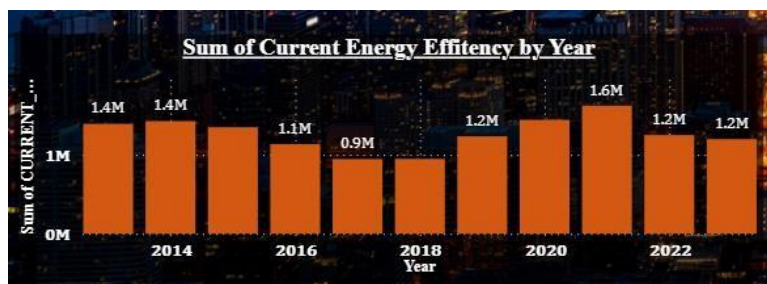
Pie chart breaking down energy efficiency by constituency

- Manchester Central: 35.3% (5M units)
- Wythenshawe and Sale East: 18.06% (3M units)
- Manchester Withington: 14.51% (2M units)
- Other regions smaller percentages.



Postcode Map

- A geographic heatmap of energy efficiency data across Manchester, with markers pinpointing locations of property emissions and efficiencies. Black markers indicate specific areas with energy-related data.



Sum of Current Energy Efficiency by Year

Bar chart displaying energy efficiency trends from 2014 to 2022:

- Peak values of **1.4M** in 2014 and **2020**.
- A decline to **0.9M** in 2016, followed by slight increases in recent years (e.g., **1.2M** in 2022).

MAIN_FUEL	Count of PROPERTY_TYPE
anthracite	6
biogas (community)	1
biomass (community)	79
bottled LPG	18
bulk wood pellets	1
dual fuel - mineral + wood	23
electricity (community)	190
electricity (not community)	33379
Total	208324

The table shows Main fuel with count of property types.

2.6 Conclusion

The Greater Manchester Domestic Energy Performance Analyzer assignment focuses on analyzing and visualizing Energy Performance Certificate (EPC) data from Manchester's local authorities between 2013 and 2023. The goal is to create a fully functional, interactive Power BI dashboard that provides insights into energy efficiency trends and helps stakeholders make informed decisions to improve energy performance.

The project involves several key stages, starting with the creation of a SQL database to store and clean the EPC data using T-SQL. After cleaning the data, the database is connected to Power BI, where calculated columns, measures, and data models can be created using DAX to facilitate more detailed analysis. The dashboard design should prioritize user experience, featuring various visualizations such as bar charts, pie charts, maps, and line charts to represent data effectively. Interactive elements, including slicers and filters, will allow users to explore data based on factors like property type, local authority, and energy rating.

In addition, the assignment encourages incorporating key performance indicators (KPIs) to highlight critical metrics like CO2 emissions and properties with energy improvement potential. The project also allows for advanced features like the use of CTEs, stored procedures, and maps to enhance the analysis and reporting capabilities.

2.6 References

Here are some suggested references for your assignment:

EPC Open Data Communities (Dataset)

<https://epc.opendatacommunities.org/downloads/domestic#local-authority>

Energy Performance Certificate Guidance

<https://www.gov.uk/buy-sell-your-home/energy-performance-certificates>

Create an Azure SQL Database

<https://learn.microsoft.com/en-us/azure/sql-database/sql-database-create-portal>