

Household Energy Consumption Analysis

By

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Tools Used: Microsoft Excel and Power BI

INTRODUCTION

In today's world, efficient energy usage in households has become increasingly important due to rising energy costs and environmental concerns. Smart meters and home energy monitoring devices generate vast amounts of data on electricity consumption, appliance usage, and peak demand periods. However, manually tracking and interpreting this data is challenging for homeowners and energy managers.

Data analytics provides a powerful solution by transforming raw energy consumption data into actionable insights. By analyzing household energy patterns, appliance usage trends, and peak consumption periods, we can help households optimize energy usage, reduce costs, and contribute to a more sustainable environment. These insights also support better planning for energy-efficient appliances, demand response programs, and smart home automation strategies.

PROBLEM STATEMENT

Households often struggle with high electricity bills and inefficient energy use due to a lack of insight into their consumption patterns. Appliances may be operating unnecessarily, peak demand periods may be unmanaged, and energy wastage can occur without detection. Inconsistencies and gaps in energy usage data make it difficult to identify inefficiencies and take corrective action.

There is a need to analyze household energy consumption data to uncover trends, detect unusual patterns or anomalies, and provide actionable recommendations. Such analysis can enable homeowners to optimize appliance usage, reduce energy costs, improve sustainability, and ultimately contribute to smarter, more efficient households.

Key Challenges:

- Identifying patterns of excessive or inefficient energy consumption in households.
- Detecting peak demand periods that lead to higher electricity costs.
- Understanding the impact of appliance usage on overall household energy efficiency.
- Uncovering anomalies or unusual consumption trends that indicate wastage.
- Assessing differences in energy consumption behavior across households or regions.

OBJECTIVE

The objective of this analysis is to provide data-driven recommendations that households, energy managers, and policymakers can implement to optimize energy consumption. This includes identifying opportunities for cost reduction, improving appliance efficiency, promoting sustainable usage, and supporting informed decision-making in household energy management.

DATA TRANSFORMATION

The Household Energy Consumption dataset was gotten **KAGGLE** and prepared for analysis by performing data transformation and cleaning using Power Query in **Power BI**. The process ensured data consistency and reliability by selecting appropriate data types, handling blanks, checking for duplicates, and rounding numerical values where necessary.

LOADING DATA

The dataset was loaded into Power BI, and data cleaning was carried out using the “Transform Data” function. Data types were adjusted as required, decimal values were rounded to two decimal places, and the dataset was checked for inconsistencies. There were no missing values, errors, or anomalies that could affect the analysis, ensuring the dataset was ready for accurate and meaningful insights.

CREATING NEW MEASURES

To gain deeper insights into household energy consumption, several new measures were created in Power BI using DAX (Data Analysis Expressions). These measures help summarize and analyze energy usage patterns effectively.

The following measures were developed:

Average Energy per Household: Calculates the mean energy consumed by each household over a specified period, helping to identify overall consumption trends.

Average Energy per Appliance: Measures the average energy usage of each appliance across all households, highlighting devices with high or low energy demands.

Most Used Appliance: Identifies the appliance with the highest frequency of usage or energy consumption, enabling targeted energy efficiency interventions.

Peak Season: Determines the periods or months with the highest overall energy consumption, indicating peak demand periods.

Total Energy: Sums the total energy consumed by all households or appliances over the selected timeframe, providing a holistic view of consumption.

These measures enhance the analysis by enabling comparisons, identifying patterns, and supporting data-driven recommendations for optimizing household energy usage.

DATA ANALYSIS AND VISUALIZATION

The cleaned Household Energy Consumption dataset was analyzed using Power BI to uncover patterns and trends in electricity usage. Various visualizations, such as line charts, bar charts, and pie chart, were used to represent consumption patterns.

Key analyses included:

Overall Energy Consumption Trends: Tracking total household energy usage over time to identify peak consumption periods.

Appliance-Usage Analysis: Assessing the contribution of individual appliances to total energy usage to identify high-consumption devices.

Time-of-Day Consumption Patterns: Evaluating energy usage during different hours of the day to detect peak demand periods and opportunities for load shifting.

Anomaly Detection: Identifying unusual consumption spikes that may indicate energy wastage or malfunctioning appliances.

Comparative Analysis across Households: Highlighting differences in energy efficiency and usage behavior across different homes.

These analyses provide actionable insights for optimizing household energy use, reducing electricity costs, and promoting sustainable energy practices. The Power BI dashboard created will further allow stakeholders to explore the data and make informed decisions on energy management.

KEY PERFORMANCE INDICATORS (KPIs)

- **Total Energy Consumed:** The total energy consumed by households from January 2023 to January 2024 was 150,000 kWh, providing an overview of overall household energy demand.
- **Average Energy per Household:** The mean energy usage per household was 299.99 kWh, highlighting typical household consumption patterns.
- **Total Number of Households:** The dataset included 100,000 households, representing the scope of the analysis.
- **Average Energy per Appliance:** The average energy consumption per appliance was 15,000 kWh, indicating which devices contribute most to the household energy use.

These KPIs provide a clear and measurable way to monitor household energy consumption, identify trends, and evaluate opportunities for improving energy efficiency.

INSIGHTS DRAWN FROM ANALYSIS

1. The highest total energy consumption by appliance was recorded for **Air Conditioners**, with **35,233.06 kWh**, while the appliance with the lowest energy usage was the **Fridge**, recorded at **2,961.97 kWh**.
2. The appliance with the highest usage percentage over the period was **Lights** at **10.2%**, whereas the appliance with the lowest usage was **TV**, accounting for **9.91%** of total consumption.

3. The peak energy consumption season was winter, February 2023, with **503.35 kWh**, while the season with the lowest consumption was winter, March 14, 2023, with **325.07 kWh**.
4. For the sum of energy consumption by household, **Home ID 324** had the highest total at **58.75 kWh**, and **Home ID 61** had the lowest total at **13.06 kWh**.
5. The peak time of energy usage was observed at **6:12:00 AM**, with a total consumption of **138.17 kWh**.
6. For household occupancy, the single-person (1) household with **Home ID 20175** had a total energy consumption of **30,417.02 kWh**, while the two-person (2) household with **Home ID 19692** recorded the lowest total energy consumption of **29,796.97 kWh**.

The Power BI dashboard is interactive, featuring slicers and tables to allow users to explore the data, monitor energy consumption, and gain actionable insights.

RECOMMENDATIONS

Based on the analysis of household energy consumption, the following recommendations are proposed:

- **Optimize Appliance Usage:** Encourage households to monitor high-energy appliances, such as air conditioners, and adopt energy-saving practices or schedules to reduce unnecessary consumption.
- **Shift Peak-Time Usage:** Promote shifting energy-intensive activities to off-peak hours to reduce strain on the grid and lower electricity costs.
- **Energy-Efficient Appliances:** Invest in energy-efficient appliances, especially for devices with high consumption, to reduce total household energy use.
- **Seasonal Awareness:** Provide households with insights on peak consumption seasons, such as winter, to plan energy usage more efficiently.
- **Interactive Monitoring Tools:** Utilize interactive dashboards for continuous monitoring, enabling households to track real-time energy usage and make data-driven decisions.

CONCLUSION

The analysis of household energy consumption revealed key patterns in appliance usage, peak seasons, and peak times. Air conditioners and lights were identified as the highest contributors to energy use, while TVs consumed the least. Households showed variability in total energy consumption, emphasizing the need for targeted efficiency strategies.

Implementing the recommended measures, including appliance optimization, peak-time management, and adoption of energy-efficient devices, can help households reduce energy costs and promote sustainable energy usage. Interactive monitoring dashboards provide a valuable tool for tracking energy consumption, empowering users to make informed decisions and improve overall energy efficiency.

Link to Power BI Dashboard:

https://drive.google.com/file/d/1SAsSji5l3ocQbhWxECXc_UBUAnNR_PXJ/view?usp=sharing