Business Insights Report

Summary

This report provides a comprehensive analysis of energy usage trends across various building types, evaluates the influence of external factors such as seasonality and temperature, and identifies anomalies suggesting potential inefficiencies or energy waste. The findings aim to support strategic planning for energy optimization, cost reduction, and future energy consumption forecasting.

Introduction

Effective energy management is crucial for operational efficiency, cost savings, and sustainability initiatives. By analyzing energy consumption patterns across different building categories and identifying anomalies, we can prioritize areas for intervention, improve energy efficiency, predict future consumption patterns, and reduce environmental impact.

Energy Usage Trends

The total energy usage by building type (sum of all utilities) indicates that:

- Education buildings dominate consumption with 70.6 billion units. (EDA Fig.1)
- Office buildings follow with 41.6 billion units.
- Entertainment/Public Assembly buildings account for 22.0 billion units.
- Public Services use approximately 20.4 billion units.

Education facilities are the largest consumers, highlighting the importance of targeting these buildings for energy efficiency improvements.

Influence of External Factors

Monthly Patterns:

- Electricity usage is highest during summer months (June–August).
- Gas consumption peaks in winter (January–February).
- Hot Water usage mirrors gas trends, being highest in colder months.

Hourly Patterns:

- Electricity and gas usage increase during business hours (8AM–5PM).
- Solar production peaks between 12PM and 2PM.

Temperature Correlation:

- Extreme cold and hot temperatures drive higher electricity usage due to heating and cooling needs.

- Gas usage significantly increases in colder temperatures.

- Hot water consumption is notably higher during colder periods.

Anomaly Detection

Buildings with abnormal energy usage (EDA pg 3)

Significant outliers based on Z-scores (> 2.5 or < -2.5) include:

- Eagle_education_Brooke (Education) – Z-Score: 25.93

- Hog_education_Robert (Education) – Z-Score: 13.89

- Eagle_public_Preston (Public Services) – Z-Score: 9.77

- Eagle_office_Sonya (Office) – Z-Score: 8.79

These buildings demonstrate significantly higher consumption compared to their peers and warrant immediate audits.

Time periods with unusual energy spikes

Identified periods with unusual energy spikes:

- Gas Usage: February mornings (Hours 8–9)

- Irrigation Usage: November and December early mornings (Hours 2–5)

- Solar Usage: November afternoons (Hours 12–14)

- Water Usage: November midday (Hours 11–14)

Operational reviews during these times may reveal inefficiencies or unnecessary usage.

Recommendations

Investment opportunities:

- Building Upgrades: Invest in energy-efficient systems (e.g., smart HVAC, LED lighting) for high-energy consuming buildings such as education and office buildings.

- Renewable Energy: Consider increasing investments in solar energy production, especially during peak hours (noon–2 PM).

Prioritizing Improvements:

- Immediate Actions: Focus on buildings with the highest Z-scores (Eagle_education_Brooke, Hog_education_Robert) to address significant inefficiencies.

- Seasonal Adjustments: Optimize energy usage for periods of peak electricity (summer) and gas (winter) demands.

- Anomaly Mitigation: Address abnormal energy behavior during specific time periods (e.g., gas usage during February mornings) through system adjustments or behavioral changes.

Prioritize Buildings > 5 SDs Above Average User:

- **Top 9 usage (in order): (EDA pg. 1)**
    - Eagle_education_Brooke (Education)
    - Hog_education_Robert (Education)
    - Eagle_public_Preston (Public services)
    - Eagle_education_Luther (Education)
    - Eagle_public_Pearle (Public services)
    - Eagle_office_Sonya (Office)
    - Eagle_assembly_Lacy (Entertainment/public assembly)
    - Eagle_assembly_Margret (Entertainment/public assembly)
    - Eagle_assembly_Ian (Entertainment/public assembly)

- With a total of about 166 billion kWh of usage across all building types, to achieve a 20% reduction we would need to reduce this number by about 33 billion kWh. If we look at just the buildings that use more than 5 standard deviations above the average building, they account for about 70 billion kWh of usage. By dividing our 33 billion kWh goal by the 70 billion kWh used by these top 9 buildings, we find that by reducing these 9 buildings' usage by roughly 47%, we could achieve our 20% goal.

Conclusion

This analysis highlights substantial opportunities to optimize energy usage, particularly within education and office buildings. Addressing detected anomalies, forecasting seasonal demand, and strategically investing in infrastructure upgrades can lead to significant energy and cost savings. The recommendations can feasibly achieve the 20% waste reduction goal by targeting inefficiencies in high Z-score buildings, optimizing seasonal usage, and leveraging low-cost behavioral changes.