Business Insight Report: The Smart Energy Dilemma

Team Name: CipherSci
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Executive Summary

Our analysis of energy consumption patterns across 1,600+ commercial buildings revealed major insights into when and where energy is most heavily used, as well as critical data gaps impacting accurate decision-making. Key findings suggest targeted operational improvements during peak daytime hours, priority retrofits for top-consuming buildings, and strategic interventions to address sites with excessive missing data. These recommendations are projected to contribute significantly toward the REIT's goal of a 20% reduction in energy waste over the next two years.

Key Findings

1. Energy Usage by Time of Day

- Energy consumption peaks between **07:30 and 18:00**, aligning with business hours.
- Highest average usage (~169 kWh) occurs at **14:00**.
- Lowest average usage (~126 kWh) is observed at **03:00**.

Opportunity:

The clear peak in energy consumption during standard business hours presents a strong opportunity for operational optimization. EcoSmart Solutions can significantly reduce unnecessary usage during peak times by implementing smart building automation systems, such as dynamic HVAC scheduling, adaptive lighting controls, and occupancy-driven energy management. These technologies can adjust building systems in real-time based on actual occupancy and external conditions, improving efficiency without compromising comfort. Focusing on demand response strategies around the 14:00 peak can further lower energy costs.

2. Energy Usage by Building Type

- The highest energy consumption is by **health buildings**, averaging **300 kWh**.
- The second highest energy consumption is by **education buildings**, at around **180 kWh**.
- **Utility**, **science**, and **office** buildings follow, consuming between **150 and 190 kWh**.
- All other building types consume less than **100 kWh**.

Opportunity:

Given that health and education buildings are the largest consumers of energy, targeted energy efficiency programs should begin within these building types. Prioritizing retrofitting projects, optimizing HVAC systems, and incorporating renewable energy solutions for health and education facilities can deliver substantial savings. Additionally, understanding the specific operational needs of these building types allows for tailored energy conservation measures that maintain functionality while reducing waste. Utility, science, and office buildings, which are close behind in consumption, can be included in a second wave of improvements to broaden the impact.

3. Building-Specific Energy Patterns

- **Top Energy Consumers**:
    - Hog Education (Janell): ~3400 kWh
    - Fox Education (Willis): ~2400 kWh
    - Rat Office (Colby): ~2100 kWh

- Outlier events (extreme spikes) were detected in select buildings, such as Fox Education (Leota) in April and July 2017.
- The top 20 highest-consuming buildings account for a disproportionate share of overall energy use, ranging between 1000 to 3500 kWh on average.
- Several buildings, such as Swan Unknown (Rocco) and Hog Office (Lanell), show high variability and volatility in their meter readings, indicating possible equipment inefficiencies or maintenance issues.

Opportunity:

Targeting the top 20 highest-consuming buildings presents a significant opportunity to drive immediate and impactful energy savings. By prioritizing energy audits, predictive maintenance, and retrofit programs for these sites, EcoSmart Solutions can maximize return on investment while addressing the largest sources of inefficiency. Special attention should be given to buildings that demonstrated extreme usage spikes, such as Fox Education (Leota), where abnormal patterns may signal equipment failures, scheduling issues, or operational inefficiencies. In addition, implementing real-time energy monitoring and submetering in buildings with high variability, like Swan Unknown (Rocco), would allow for early detection of anomalies, faster maintenance responses, and a more proactive energy management strategy across the portfolio.

4. Variability and Anomalies

- Buildings like Hog Office (Lanell) and Swan Unknown (Rocco) showed significant variability with numerous outliers.
- Rat Public (Grover) showed minimal variability, suggesting predictable, stable energy usage.

Opportunity:

Buildings with significant variability and frequent outlier events, such as Hog Office (Lanell) and Swan Unknown (Rocco), represent high-priority targets for intervention.

These anomalies could indicate faulty meters, inefficient equipment, or inconsistent operational practices. Conducting detailed audits and recalibrating sensors at these sites can greatly improve data reliability. In addition, deploying advanced predictive control systems that adapt to real-time building conditions will help stabilize energy consumption and prevent costly inefficiencies. On the opposite end, low-variability buildings like Rat Public (Grover) can serve as models for best practices in operational consistency.

5. Data Completeness Challenges

- Sites with most missing data:
  - Swan (~50% missing)
  - Shrew (~45% missing)
  - Bobcat (~28% missing)

- Building types with highest missing data:
  - Unknown buildings (~50%)
  - Science buildings (~20%)

Opportunity:

High rates of missing data, particularly at sites like Swan, Shrew, and Bobcat, as well as within unknown and science building types, pose a serious challenge to accurate forecasting and decision-making. To address this, targeted efforts should prioritize meter maintenance, sensor upgrades, and regular data validation at these critical locations. Improving data completeness will enhance the reliability of predictive models, allow for better benchmarking across buildings, and prevent miscalculations caused by incomplete or misleading information. Investing in data quality upfront will support more confident, data-driven infrastructure planning and energy optimization.

6. Relationship Between Energy Usage and Air Temperature

- **Trend**: The line of best fit shows a gradual increase in energy usage as air temperature rises, indicating a positive correlation between the two variables.

- **Implications**: As air temperature increases, buildings tend to consume more energy, likely due to higher cooling demands as outdoor temperatures rise.

Opportunity:

Invest in energy-efficient cooling systems and smart building technologies that can dynamically adjust HVAC settings based on real-time temperature data. This would help reduce energy consumption during warmer temperatures and potentially cut cooling costs.

Conclusion

The analysis of energy usage patterns across various buildings highlights significant opportunities for optimizing energy consumption and improving operational efficiency. By leveraging data-driven insights, such as the peak usage times, variability in energy patterns, and the relationship between energy consumption and external factors like temperature, EcoSmart Solutions can strategically target high-energy-consuming buildings for retrofitting and maintenance. Specifically, prioritizing buildings with significant variability in energy use, addressing missing data issues, and implementing smart automation for HVAC and lighting systems can contribute to substantial energy savings. Additionally, focusing on the most energy-intensive building types, such as healthcare and education, can maximize return on investment for energy-saving initiatives.

As buildings continue to become more energy-efficient and data-driven, there is a clear opportunity to reduce operational costs, mitigate environmental impact, and support sustainability goals. With these actionable recommendations, EcoSmart

Solutions can move forward with a more streamlined and effective approach to energy optimization, achieving their target of reducing energy waste by 20% over the next two years.