

weekly_patterns

May 11, 2025

1 Weekly Patterns in Energy and Gas Usage Report

This notebook analyzes weekly patterns in electricity and gas usage and tests for significant differences across days using ANOVA.

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[1]: # Import libraries
import pandas as pd
import matplotlib.pyplot as plt
from home_messages_db import HomeMessagesDB
from scipy import stats

# Connect to database
db = HomeMessagesDB('sqlite:///smarthome.db')

# Fetch data
electricity_data = db.query_electricity()
gas_data = db.query_gas()

# Convert to DataFrames and calculate differences
electricity_df = pd.DataFrame([(e.epoch, e.t1_kwh, e.t2_kwh) for e in
    ↪electricity_data],
                               columns=['epoch', 't1_kwh', 't2_kwh']).
    ↪sort_values('epoch')
gas_df = pd.DataFrame([(g.epoch, g.gas_m3) for g in gas_data],
                       columns=['epoch', 'gas_m3']).sort_values('epoch')

electricity_df['t1_kwh_diff'] = electricity_df['t1_kwh'].diff().fillna(0)
electricity_df['t2_kwh_diff'] = electricity_df['t2_kwh'].diff().fillna(0)
gas_df['gas_m3_diff'] = gas_df['gas_m3'].diff().fillna(0)

# Filter out negative differences
electricity_df = electricity_df[(electricity_df['t1_kwh_diff'] >= 0) &
    ↪(electricity_df['t2_kwh_diff'] >= 0)]
gas_df = gas_df[gas_df['gas_m3_diff'] >= 0]

# Convert epoch to datetime and extract day of week
electricity_df['datetime'] = pd.to_datetime(electricity_df['epoch'], unit='s',
    ↪utc=True)
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electricity_df['day_of_week'] = electricity_df['datetime'].dt.day_name()
gas_df['datetime'] = pd.to_datetime(gas_df['epoch'], unit='s', utc=True)
gas_df['day_of_week'] = gas_df['datetime'].dt.day_name()

# Aggregate by day of week
weekly_electricity = electricity_df.groupby('day_of_week').agg({'t1_kwh_diff': 'mean', 't2_kwh_diff': 'mean'}).reset_index()
weekly_gas = gas_df.groupby('day_of_week').agg({'gas_m3_diff': 'mean'}).reset_index()

# Order days of week
days_order = ['Monday', 'Tuesday', 'Wednesday', 'Thursday', 'Friday', 'Saturday', 'Sunday']
weekly_electricity['day_of_week'] = pd.Categorical(weekly_electricity['day_of_week'], categories=days_order, ordered=True)
weekly_gas['day_of_week'] = pd.Categorical(weekly_gas['day_of_week'], categories=days_order, ordered=True)
weekly_electricity = weekly_electricity.sort_values('day_of_week')
weekly_gas = weekly_gas.sort_values('day_of_week')

# Close database connection
db.close()

# Display the first few rows
weekly_electricity.head(), weekly_gas.head()

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[1]: (  day_of_week  t1_kwh_diff  t2_kwh_diff
      1      Monday      0.034375      0.054120
      5      Tuesday      0.029379      0.057002
      6  Wednesday      0.031554      0.061312
      4   Thursday      0.032527      0.054932
      0    Friday      0.031745      0.061905,
      day_of_week  gas_m3_diff
      1      Monday      0.030637
      5      Tuesday      0.029048
      6  Wednesday      0.030957
      4   Thursday      0.030014
      0    Friday      0.030543)

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[2]: # Plot weekly patterns
plt.figure(figsize=(10, 6))
plt.plot(weekly_electricity['day_of_week'], weekly_electricity['t1_kwh_diff'], label='T1 Electricity (kWh)', marker='o')
plt.plot(weekly_electricity['day_of_week'], weekly_electricity['t2_kwh_diff'], label='T2 Electricity (kWh)', marker='o')

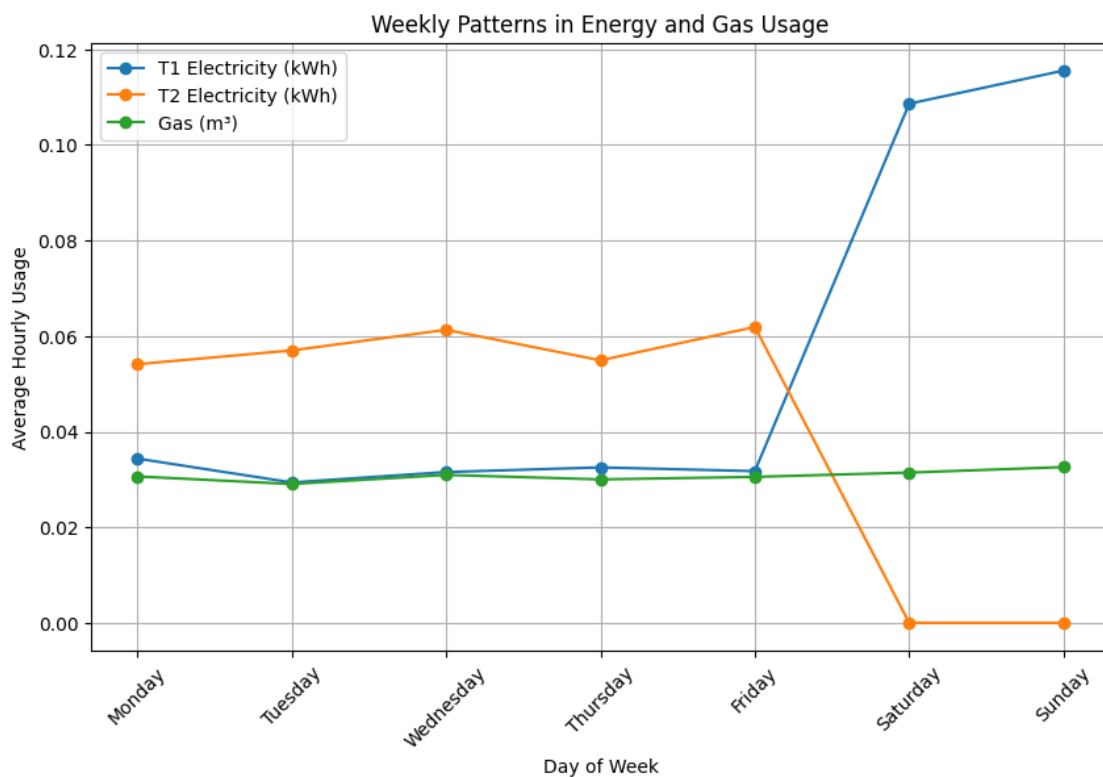
```

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plt.plot(weekly_gas['day_of_week'], weekly_gas['gas_m3_diff'], label='Gas_
↪(m³)', marker='o')
plt.xlabel('Day of Week')
plt.ylabel('Average Hourly Usage')
plt.title('Weekly Patterns in Energy and Gas Usage')
plt.legend()
plt.xticks(rotation=45)
plt.grid(True)

# Save the plot
plt.savefig('weekly_usage_patterns.png')
plt.show()

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[3]: # Perform ANOVA test for T1 electricity
t1_data_by_day = [electricity_df[electricity_df['day_of_week'] ==_
↪day]['t1_kwh_diff'].dropna().values for day in days_order]
f_statistic, p_value = stats.f_oneway(*t1_data_by_day)
print(f'ANOVA Test for T1 Electricity: F-statistic = {f_statistic:.2f}, p-value_
↪= {p_value:.4f}')

# Interpretation
alpha = 0.05

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if p_value < alpha:
    print('Reject the null hypothesis: There are significant differences in T1_
    ↪electricity usage across days.')
else:
    print('Fail to reject the null hypothesis: No significant differences in T1_
    ↪electricity usage across days.')

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ANOVA Test for T1 Electricity: F-statistic = 2687.07, p-value = 0.0000

Reject the null hypothesis: There are significant differences in T1 electricity usage across days.

1.1 Analysis

- **Weekly Patterns:** The graph shows how much electricity (T1 and T2) and gas are used on average each hour over the week. You can see that Saturday has the highest usage for T1 electricity, reaching about 0.12 kWh, while Sunday also shows a big jump for T1 and T2 electricity. Weekdays like Monday to Friday have more steady usage, with T2 electricity peaking around 0.06 kWh on Friday. Gas usage stays pretty low and stable all week, around 0.03 m³, with a small increase on Saturday.
- **Statistical Component (ANOVA):** The ANOVA test helps us figure out if the differences in T1 electricity usage between days are important. The F-statistic is 2687.07, and the p-value is 0.0000, which is way less than 0.05. This means we can reject the null hypothesis and say there are definitely significant differences in T1 electricity usage across the days of the week. So, the pattern we see in the graph isn't just random—it shows real changes depending on the day!