

Energy Efficiency Analysis

Presented by Nawal, Sam, Maryna

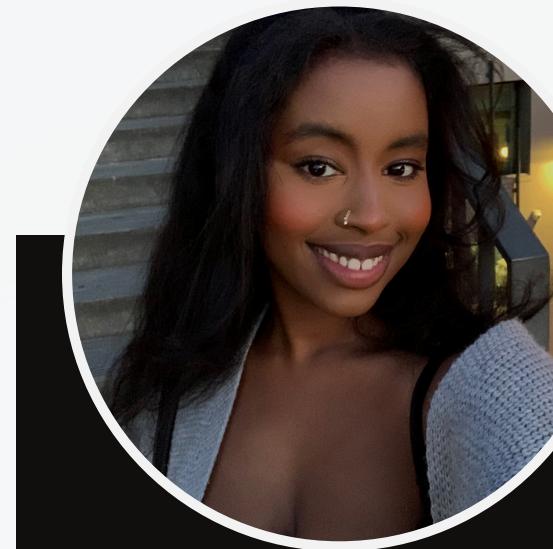
OUR TEAM



Maryna
Sivachenko
Coding
Idea



Sam Park
Coding



Nawal Haji
Project/Program
management
Idea

DATA HANDLING

raw data

clean data

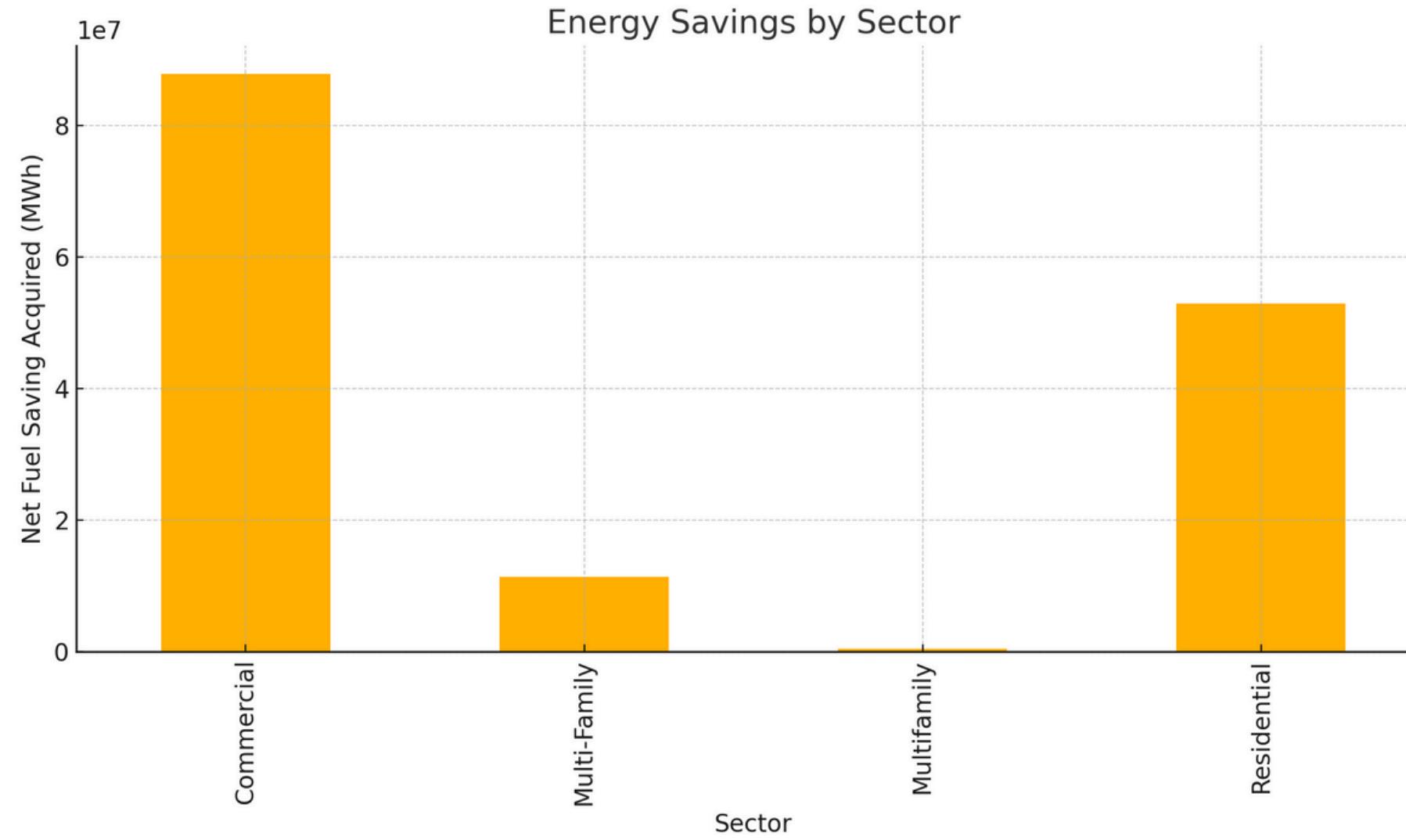
| NYEnergySaving | | | | | |
|---|--|-----------|--------------|---------------------------|----------------------------------|
| Program Administrator | Program Name | Fuel Type | Sector | Net Fuel Savings Acquired | Fuel Savings Acquired as of Date |
| Central Hudson Gas & Electric Corporation | Expanded Residential HVAC Program | Electric | Residential | 0 MWh | 9-12-31T00:00:00.000 |
| Central Hudson Gas & Electric Corporation | Home Energy Reporting | Electric | Residential | 74836.28 MWh | 9-12-31T00:00:00.000 |
| Central Hudson Gas & Electric Corporation | Home Energy Reporting | Gas | Residential | 97050.76 Dth | 9-12-31T00:00:00.000 |
| Central Hudson Gas & Electric Corporation | Mid-Size Commercial Business Program | Electric | Commercial | 35711.02 MWh | 9-12-31T00:00:00.000 |
| Central Hudson Gas & Electric Corporation | Residential Appliance Recycling Program | Electric | Residential | 19562.37 MWh | 9-12-31T00:00:00.000 |
| Central Hudson Gas & Electric Corporation | * Residential HVAC Program | Electric | Residential | 125.683 MWh | 9-12-31T00:00:00.000 |
| Central Hudson Gas & Electric Corporation | Residential HVAC Program | Electric | Residential | 8083.90 MWh | 9-12-31T00:00:00.000 |
| Central Hudson Gas & Electric Corporation | Residential HVAC Program | Gas | Residential | 61367.23 Dth | 9-12-31T00:00:00.000 |
| Central Hudson Gas & Electric Corporation | * Small and Mid-Size Commercial Buildings | Electric | Commercial | 16.276 MWh | 9-12-31T00:00:00.000 |
| Central Hudson Gas & Electric Corporation | Small and Mid-Size Commercial Buildings | Gas | Commercial | 11732.26 Dth | 9-12-31T00:00:00.000 |
| Central Hudson Gas & Electric Corporation | Small Business Direct Install Program | Electric | Commercial | 90577.44 MWh | 9-12-31T00:00:00.000 |
| Consolidated Edison Company of New York, Inc. | Appliance Bounty Program | Electric | Residential | 17402.20 MWh | 9-12-31T00:00:00.000 |
| Consolidated Edison Company of New York, Inc. | * C&I Custom Efficiency Program | Gas | Commercial | -95801.68 Dth | 9-12-31T00:00:00.000 |
| Consolidated Edison Company of New York, Inc. | C&I Custom Efficiency Program | Electric | Commercial | 241090.03 MWh | 9-12-31T00:00:00.000 |
| Consolidated Edison Company of New York, Inc. | C&I Custom Gas Efficiency Program | Gas | Commercial | 188249.07 Dth | 9-12-31T00:00:00.000 |
| Consolidated Edison Company of New York, Inc. | * C&I Equipment Rebate Program | Gas | Commercial | -41167.54 Dth | 9-12-31T00:00:00.000 |
| Consolidated Edison Company of New York, Inc. | C&I Equipment Rebate Program | Electric | Commercial | 231290.66 MWh | 9-12-31T00:00:00.000 |
| Consolidated Edison Company of New York, Inc. | C&I Gas Efficient Equipment Rebate Program | Gas | Commercial | 345424.03 Dth | 9-12-31T00:00:00.000 |
| Consolidated Edison Company of New York, Inc. | * Multifamily Energy Efficiency Program | Gas | Multi-Family | -37475.33 Dth | 9-12-31T00:00:00.000 |
| Consolidated Edison Company of New York, Inc. | Multifamily Energy Efficiency Program | Electric | Multi-Family | 64221.18 MWh | 9-12-31T00:00:00.000 |
| Consolidated Edison Company of New York, Inc. | Multifamily Energy Efficiency Program | Gas | Multi-Family | 700200.35 Dth | 9-12-31T00:00:00.000 |
| Consolidated Edison Company of New York, Inc. | Multifamily Low-Income Program | Gas | Multi-Family | 124578.13 Dth | 9-12-31T00:00:00.000 |
| Consolidated Edison Company of New York, Inc. | * Residential Direct Installation Program | Gas | Residential | 21.738 Dth | 9-12-31T00:00:00.000 |
| Consolidated Edison Company of New York, Inc. | Residential Direct Installation Program | Electric | Residential | 2663.10 MWh | 9-12-31T00:00:00.000 |
| Consolidated Edison Company of New York, Inc. | Residential Electric Program | Electric | Residential | 39450.54 MWh | 9-12-31T00:00:00.000 |
| Consolidated Edison Company of New York, Inc. | * Residential HVAC Program | Electric | Residential | 669.394 MWh | 9-12-31T00:00:00.000 |
| Consolidated Edison Company of New York, Inc. | Residential HVAC Program | Electric | Residential | 6443.58 MWh | 9-12-31T00:00:00.000 |
| Consolidated Edison Company of New York, Inc. | Residential HVAC Program | Gas | Residential | 191926.90 Dth | 9-12-31T00:00:00.000 |
| Consolidated Edison Company of New York, Inc. | Residential Room Air Conditioning Program | Electric | Residential | 3213.46 MWh | 9-12-31T00:00:00.000 |
| Consolidated Edison Company of New York, Inc. | * Small Business Direct Install Program | Gas | Commercial | -349.684 Dth | 9-12-31T00:00:00.000 |

| ProgramAdministrator | ProgramName | FuelType | Sector | NetFuelSavingAcquired,MWh | Success |
|--|---|----------|--------------|---------------------------|---------|
| 1 Central Hudson Gas & Electric Corporation | Home Energy Reporting | Electric | Residential | 74836.28 | 1 |
| 2 Central Hudson Gas & Electric Corporation | Home Energy Reporting | Gas | Residential | 28442.666233200000 | 1 |
| 3 Central Hudson Gas & Electric Corporation | Mid-Size Commercial Business Program | Electric | Commercial | 35711.02 | 1 |
| 4 Central Hudson Gas & Electric Corporation | Residential Appliance Recycling Program | Electric | Residential | 19562.37 | 1 |
| 5 Central Hudson Gas & Electric Corporation | Residential HVAC Program | Electric | Residential | 125.683 | 1 |
| 6 Central Hudson Gas & Electric Corporation | Residential HVAC Program | Electric | Residential | 8083.9 | 1 |
| 7 Central Hudson Gas & Electric Corporation | Residential HVAC Program | Gas | Residential | 17984.8940961 | 1 |
| 8 Central Hudson Gas & Electric Corporation | Small and Mid-Size Commercial Buildings | Electric | Commercial | 16.276 | 1 |
| 9 Central Hudson Gas & Electric Corporation | Small and Mid-Size Commercial Buildings | Gas | Commercial | 3438.373438200000 | 1 |
| 10 Central Hudson Gas & Electric Corporation | Small Business Direct Install Program | Electric | Commercial | 90577.44 | 1 |
| 11 Consolidated Edison Company of New York, Inc. | Appliance Bounty Program | Electric | Residential | 17402.2 | 1 |
| 13 Consolidated Edison Company of New York, Inc. | C&I Custom Efficiency Program | Electric | Commercial | 241090.03 | 1 |
| 14 Consolidated Edison Company of New York, Inc. | C&I Custom Gas Efficiency Program | Gas | Commercial | 55170.1549449 | 1 |
| 16 Consolidated Edison Company of New York, Inc. | C&I Equipment Rebate Program | Electric | Commercial | 231290.66 | 1 |
| 17 Consolidated Edison Company of New York, Inc. | C&I Gas Efficient Equipment Rebate Program | Gas | Commercial | 101233.4204721000 | 1 |
| 19 Consolidated Edison Company of New York, Inc. | Multifamily Energy Efficiency Program | Electric | Multi-Family | 64221.18 | 1 |
| 20 Consolidated Edison Company of New York, Inc. | Multifamily Energy Efficiency Program | Gas | Multi-Family | 205207.7165745 | 1 |
| 21 Consolidated Edison Company of New York, Inc. | Multifamily Low-Income Program | Gas | Multi-Family | 36510.1125591 | 1 |
| 22 Consolidated Edison Company of New York, Inc. | Residential Direct Installation Program | Gas | Residential | 6.3707556600000000 | 1 |
| 23 Consolidated Edison Company of New York, Inc. | Residential Direct Installation Program | Electric | Residential | 2663.1 | 1 |
| 24 Consolidated Edison Company of New York, Inc. | Residential Electric Program | Electric | Residential | 39450.54 | 1 |
| 25 Consolidated Edison Company of New York, Inc. | Residential HVAC Program | Electric | Residential | 669.394 | 1 |
| 26 Consolidated Edison Company of New York, Inc. | Residential HVAC Program | Electric | Residential | 6443.58 | 1 |
| 27 Consolidated Edison Company of New York, Inc. | Residential HVAC Program | Gas | Residential | 56248.016583 | 1 |
| 28 Consolidated Edison Company of New York, Inc. | Residential Room Air Conditioning Program | Electric | Residential | 3213.46 | 1 |
| 30 Consolidated Edison Company of New York, Inc. | Small Business Direct Install Program | Electric | Commercial | 506043.82 | 1 |
| 31 Corning Natural Gas Corporation | Residential HVAC Program | Gas | Residential | 7387.29826200000 | 1 |
| 32 Corning Natural Gas Corporation | Small Commercial HVAC Program | Gas | Commercial | 409.799781 | 1 |
| 33 KeySpan Gas East Corp. d/b/a National Grid | Commercial Energy Efficiency Program | Gas | Commercial | 25570.436628900000 | 1 |
| 34 KeySpan Gas East Corp. d/b/a National Grid | Commercial & Industrial Gas Energy Efficiency Program | Gas | Commercial | 100563.4800363000 | 1 |

DATA ANALYSIS & VISUALIZATION

Mission

Vision



NYEnergyCleanPredicted

(?) Table data was imported. [Adjust Settings](#)

| ProgramAdministrator | ProgramName | FuelType | Sector | NetFuelSavingAcquired,MWh | SuccessRate | Predicted |
|---|--|----------|--------------|---------------------------|-------------|-----------|
| Central Hudson Gas & Electric Corporation | Home Energy Reporting | Electric | Residential | 74836.28 | 1 | |
| Central Hudson Gas & Electric Corporation | Home Energy Reporting | Gas | Residential | 28442.6662332 | 1 | |
| Central Hudson Gas & Electric Corporation | Mid-Size Commercial Business Program | Electric | Commercial | 35711.02 | 0 | |
| Central Hudson Gas & Electric Corporation | Residential Appliance Recycling Program | Electric | Residential | 19562.37 | 0 | |
| Central Hudson Gas & Electric Corporation | Residential HVAC Program | Electric | Residential | 125.683 | 0 | |
| Central Hudson Gas & Electric Corporation | Residential HVAC Program | Electric | Residential | 8083.9 | 0 | |
| Central Hudson Gas & Electric Corporation | Residential HVAC Program | Gas | Residential | 17984.8940961 | 0 | |
| Central Hudson Gas & Electric Corporation | Small and Mid-Size Commercial Buildings | Electric | Commercial | 16.276 | 0 | |
| Central Hudson Gas & Electric Corporation | Small and Mid-Size Commercial Buildings | Gas | Commercial | 3438.3734382 | 0 | |
| Central Hudson Gas & Electric Corporation | Small Business Direct Install Program | Electric | Commercial | 90577.44 | 0 | |
| Consolidated Edison Company of New York, Inc. | Appliance Bounty Program | Electric | Residential | 17402.2 | 0 | |
| Consolidated Edison Company of New York, Inc. | C&I Custom Efficiency Program | Electric | Commercial | 241090.03 | 0 | |
| Consolidated Edison Company of New York, Inc. | C&I Custom Gas Efficiency Program | Gas | Commercial | 55170.1549449 | 0 | |
| Consolidated Edison Company of New York, Inc. | C&I Equipment Rebate Program | Electric | Commercial | 231290.66 | 0 | |
| Consolidated Edison Company of New York, Inc. | C&I Gas Efficient Equipment Rebate Program | Gas | Commercial | 101233.4204721 | 0 | |
| Consolidated Edison Company of New York, Inc. | Multifamily Energy Efficiency Program | Electric | Multi-Family | 64221.18 | 0 | |
| Consolidated Edison Company of New York, Inc. | Multifamily Energy Efficiency Program | Gas | Multi-Family | 205207.7165745 | 1 | |
| Consolidated Edison Company of New York, Inc. | Multifamily Low-Income Program | Gas | Multi-Family | 36510.1125591 | 1 | |
| Consolidated Edison Company of New York, Inc. | Residential Direct Installation Program | Gas | Residential | 6.37075566 | 1 | |
| Consolidated Edison Company of New York, Inc. | Residential Direct Installation Program | Electric | Residential | 2663.1 | 0 | |
| Consolidated Edison Company of New York, Inc. | Residential Electric Program | Electric | Residential | 39450.54 | 0 | |
| Consolidated Edison Company of New York, Inc. | Residential HVAC Program | Electric | Residential | 669.394 | 0 | |
| Consolidated Edison Company of New York, Inc. | Residential HVAC Program | Electric | Residential | 6443.58 | 0 | |
| Consolidated Edison Company of New York, Inc. | Residential HVAC Program | Gas | Residential | 56248.016583 | 0 | |
| Consolidated Edison Company of New York, Inc. | Residential Room Air Conditioning Program | Electric | Residential | 3213.46 | 0 | |
| Consolidated Edison Company of New York, Inc. | Small Business Direct Install Program | Electric | Commercial | 506043.82 | 0 | |
| Corning Natural Gas Corporation | Residential HVAC Program | Gas | Residential | 7387.29826200000 | 0 | |
| Corning Natural Gas Corporation | Small Commercial HVAC Program | Gas | Commercial | 409.799781 | 0 | |
| KeySpan Gas East Corp. d/b/a National Grid | Commercial Energy Efficiency Program | Gas | Commercial | 25570.436628900000 | 0 | |

RESULTS/CONCLUSION

classification report table

| | precision | recall | f1-score | support |
|--------------|-----------|--------|----------|---------|
| Class 0 | 0.77 | 1.0 | 0.87 | 200 |
| Class 1 | 1.0 | 0.6 | 0.75 | 154 |
| Accuracy | 0.83 | | | 354 |
| Macro Avg | 0.88 | 0.8 | 0.81 | 354 |
| Weighted Avg | 0.87 | 0.83 | 0.82 | 354 |

FUTURE STEPS?

Expand the dataset to include more programs and data points for better model training."

Incorporate additional features to improve the model's predictive power. Test other machine learning algorithms to see if they offer better performance.

SUMMARY

our project involved analyzing energy efficiency programs, cleaning and preprocessing the data, and using a machine learning model to predict program success. We identified key sectors contributing to energy savings and provided actionable insights through our predictions

```
In [156]: df
for i, row in df.iterrows():
    if 'Dth' in row['FuelSavingsUnit']:
        df.at[i, 'NetFuelSavingAcquired'] = df.at[i, 'NetFuelSavingAcquired'] * 0.29307
    df['FuelSavingsUnit'] = df['FuelSavingsUnit'].str.replace('Dth', 'MWh')
    df['ProgramName'] = df['ProgramName'].str.strip()
    df['ProgramName'] = df['ProgramName'].str.replace('*', '')
    df['FuelType'] = df['FuelType'].str.replace('Electric', 'Electric')
    if 'Empower New York' in row['ProgramName']:
        df.at[i, 'ProgramName'] = 'Empower New York Program'
    elif 'NY Energy Star Homes' in row['ProgramName']:
        df.at[i, 'ProgramName'] = 'New York Energy Star Homes'
    elif 'Residential High Efficiency Heating, Water Heating & Controls' in row['ProgramName']:
        df.at[i, 'ProgramName'] = 'Residential High Efficiency Heating, Water Heating & Controls Program'

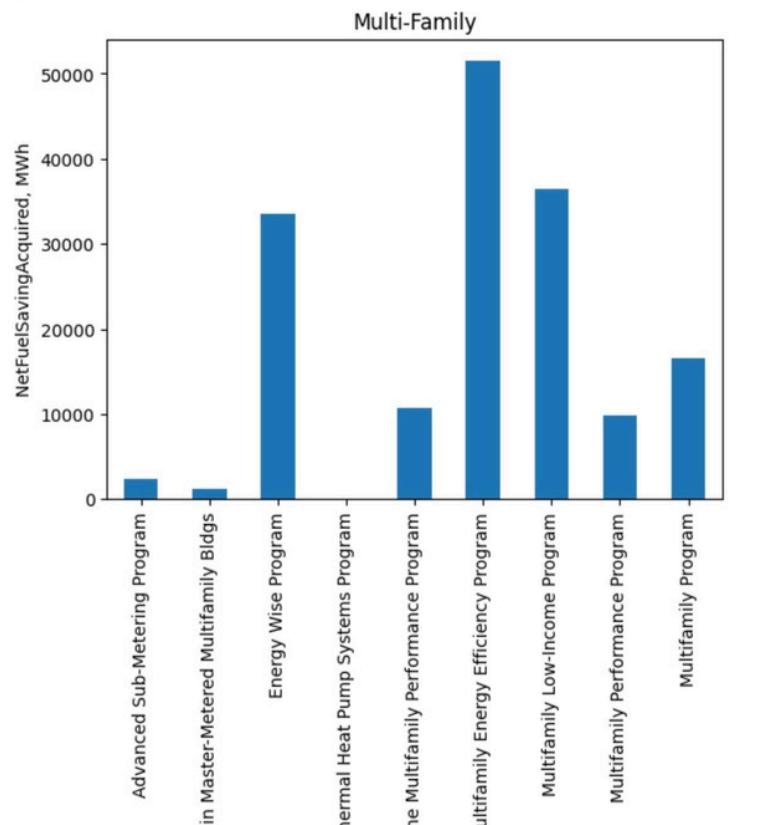
df.head(5)
```

| | ProgramAdministrator | ProgramName | FuelType | Sector | NetFuelSavingAcquired | FuelSavingsUnit | CumulativeNetEne |
|---|---|---|----------|-------------|-----------------------|-----------------|------------------|
| 0 | Central Hudson Gas & Electric Corporation | Expanded Residential HVAC Program | Electric | Residential | 0.000000 | MWh | |
| 1 | Central Hudson Gas & Electric Corporation | Home Energy Reporting | Electric | Residential | 74836.280000 | MWh | |
| 2 | Central Hudson Gas & Electric Corporation | Home Energy Reporting | Gas | Residential | 28442.666233 | MWh | |
| 3 | Central Hudson Gas & Electric Corporation | Mid-Size Commercial Business Program | Electric | Commercial | 35711.020000 | MWh | |
| 4 | Central Hudson Gas & Electric Corporation | Residential Appliance Recycling Program | Electric | Residential | 19562.370000 | MWh | |

```
In [156]: type(df_commercial)
```



```
In [156...]: mult_pr = groupper(df_multi_family, 'Program')
plotter(df_multi_family, 'Program', 'Multi-Family')
```



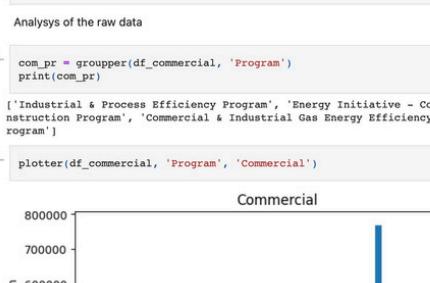
```
In [156]: def grouper(df, x):
    if x == 'Program':
        df_copy = df[['ProgramName', 'NetFuelSavingAcquired']]
        df_copy = df.groupby('ProgramName')['NetFuelSavingAcquired'].median()
        df_copy = df_copy.sort_values(ascending=False)[:5]
        df_copy = df_copy.keys().tolist()
    elif x == 'Fuel':
        df_copy = df[['FuelType', 'NetFuelSavingAcquired']]
        df_copy = df.groupby('FuelType')['NetFuelSavingAcquired'].median()
        df_copy = df_copy.sort_values(ascending=False)[:5]
        df_copy = df_copy.keys().tolist()
    elif x == 'ProgramAdministrator':
        df_copy = df[['ProgramAdministrator', 'NetFuelSavingAcquired']]
        df_copy = df.groupby('ProgramAdministrator')['NetFuelSavingAcquired'].median()
        df_copy = df_copy.sort_values(ascending=False)[:5]
        df_copy = df_copy.keys().tolist()
    else:
        print('Invalid input')
    return df_copy

Analysis of the raw data

In [156]: com_pr = grouper(df_commercial, 'Program')
print(com_pr)

['Industrial & Process Efficiency Program', 'Energy Initiative - Commercial & Industrial Electric Program', 'New Construction Program', 'Commercial & Industrial Gas Energy Efficiency Program', 'C&I Gas Efficient Equipment Rebate Program']

In [156]: plotter(df_commercial, 'Program', 'Commercial')


```



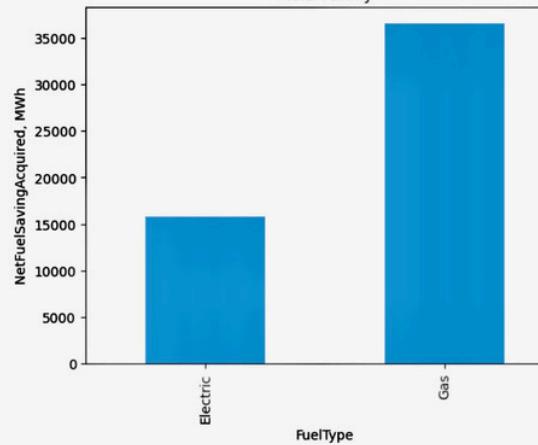
```
In [156]: df_commercial = df.loc[df['Sector'] == 'Commercial']
df_residential = df.loc[df['Sector'] == 'Residential']
df_multi_family = df.loc[df['Sector'] == 'Multi-Family']

In [156]: type(df_commercial)

Out[156]: pandas.core.frame.DataFrame

In [156]: def plotter(df, x, title):
    if x == 'Program':
        df_copy = df[['ProgramName', 'NetFuelSavingAcquired']]
        df_copy = df.groupby('ProgramName')['NetFuelSavingAcquired'].median()
        df_copy.plot(kind='bar', xlabel='ProgramName', ylabel='NetFuelSavingAcquired, MWh', title=title)
    elif x == 'Fuel':
        df_copy = df[['FuelType', 'NetFuelSavingAcquired']]
        df_copy = df.groupby('FuelType')['NetFuelSavingAcquired'].median()
        df_copy.plot(kind='bar', xlabel='FuelType', ylabel='NetFuelSavingAcquired, MWh', title=title)
    elif x == 'ProgramAdministrator':
        df_copy = df[['ProgramAdministrator', 'NetFuelSavingAcquired']]
        df_copy = df.groupby('ProgramAdministrator')['NetFuelSavingAcquired'].median()
        df_copy.plot(kind='bar', xlabel='ProgramAdministrator', ylabel='NetFuelSavingAcquired, MWh', title=title)
    else:
        print('Invalid input')

In [156]: def groupper(df, x):
    if x == 'Program':
        df_copy = df[['ProgramName', 'NetFuelSavingAcquired']]
        df_copy = df.groupby('ProgramName')['NetFuelSavingAcquired'].median()
        df_copy = df_copy.sort_values(ascending=False)[:5]
        df_copy = df_copy.keys().tolist()
    elif x == 'Fuel':
        df_copy = df[['FuelType', 'NetFuelSavingAcquired']]
        df_copy = df.groupby('FuelType')['NetFuelSavingAcquired'].median()
        df_copy = df_copy.sort_values(ascending=False)[:5]
        df_copy = df_copy.keys().tolist()
    elif x == 'ProgramAdministrator':
        df_copy = df[['ProgramAdministrator', 'NetFuelSavingAcquired']]
        df_copy = df.groupby('ProgramAdministrator')['NetFuelSavingAcquired'].median()
```



Residential

MWh

20000



In [156]:

```
plotter(df_commercial, 'Fuel', 'Commercial')
```

Commercial

A bar chart titled "Commercial" showing the net fuel saving acquired in MWh for two fuel types: Electric and Gas. The y-axis ranges from 0 to 40,000 MWh. The "Electric" bar reaches approximately 43,000 MWh, while the "Gas" bar reaches approximately 17,000 MWh.

| FuelType | NetFuelSavingAcquired, MWh |
|----------|----------------------------|
| Electric | ~43,000 |
| Gas | ~17,000 |

In [157]:

```
plotter(df_multi_family, 'Fuel', 'Multi-Family')
```

Multi-Family

A bar chart titled "Multi-Family" showing the net fuel saving acquired in MWh for one fuel type. The y-axis ranges from 0 to 35,000 MWh. The single bar reaches approximately 35,000 MWh.

| FuelType | NetFuelSavingAcquired, MWh |
|----------|----------------------------|
| Electric | ~35,000 |

THANK'S FOR YOUR TIME!

Discussion questions?

1. *What additional features or data should we consider including in future analyses to enhance our understanding of energy efficiency program performance?*
- 2.
3. *Based on our findings, what strategies could be implemented to improve the success rates of energy efficiency programs in sectors that currently show lower savings?*

