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Ironhack Data Analytics Bootcamp
Final Project
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Energy efficiency of residential homes

Why work on energy efficiency?

1. **Climate Change:**

- Energy sector, responsible for two-thirds of greenhouse gas emissions, must prioritize renewable energy, **improve efficiency**, and transform to combat global warming
- Balancing energy provision for a growing population with climate change mitigation is crucial (BMZ, 2020)

2. **Unstable energy prices**

- Example: EU energy prices hit record levels in 2022
  - Driven by global wholesale energy price surge since 2021
  - Compounded by COVID-19 impact, rising international demand, Russian invasion of Ukraine, and heatwaves in energy markets (Council of the EU, 2024)

Background

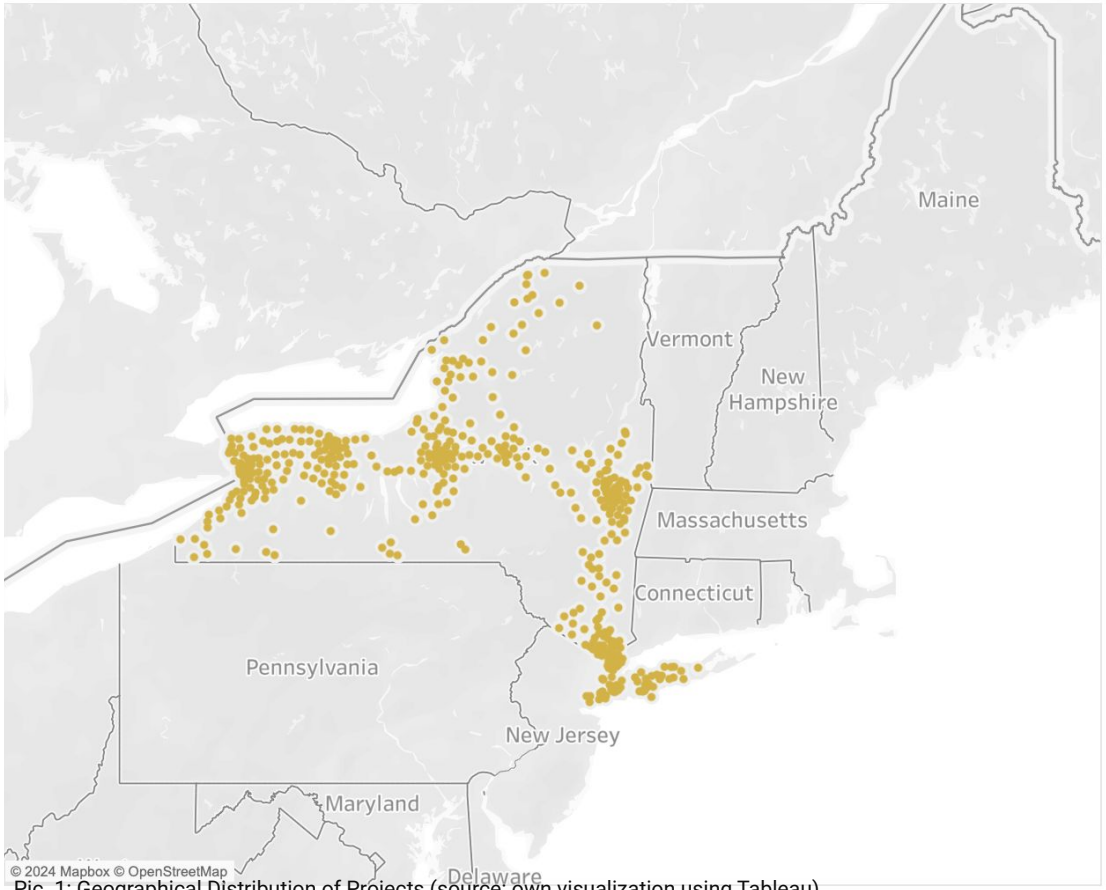
About the Home Performance Program

- Home Performance with ENERGY STAR® Program is overseen by U.S. EPA and DOE
- Focuses on promoting energy efficiency in homes
- Analysis includes comparing estimated savings against normalized values using an open-source energy efficiency meter
- National collaborative program since 2001 between U.S. DOE and U.S. EPA
- Involves a network of 32 utility and nonprofit sponsors and 1,300 home performance contractors
- Trusted source aiding contractors and energy programs in delivering home energy upgrades
- Upgrades aim to make US-American homes **safer, healthier, and more energy-efficient**

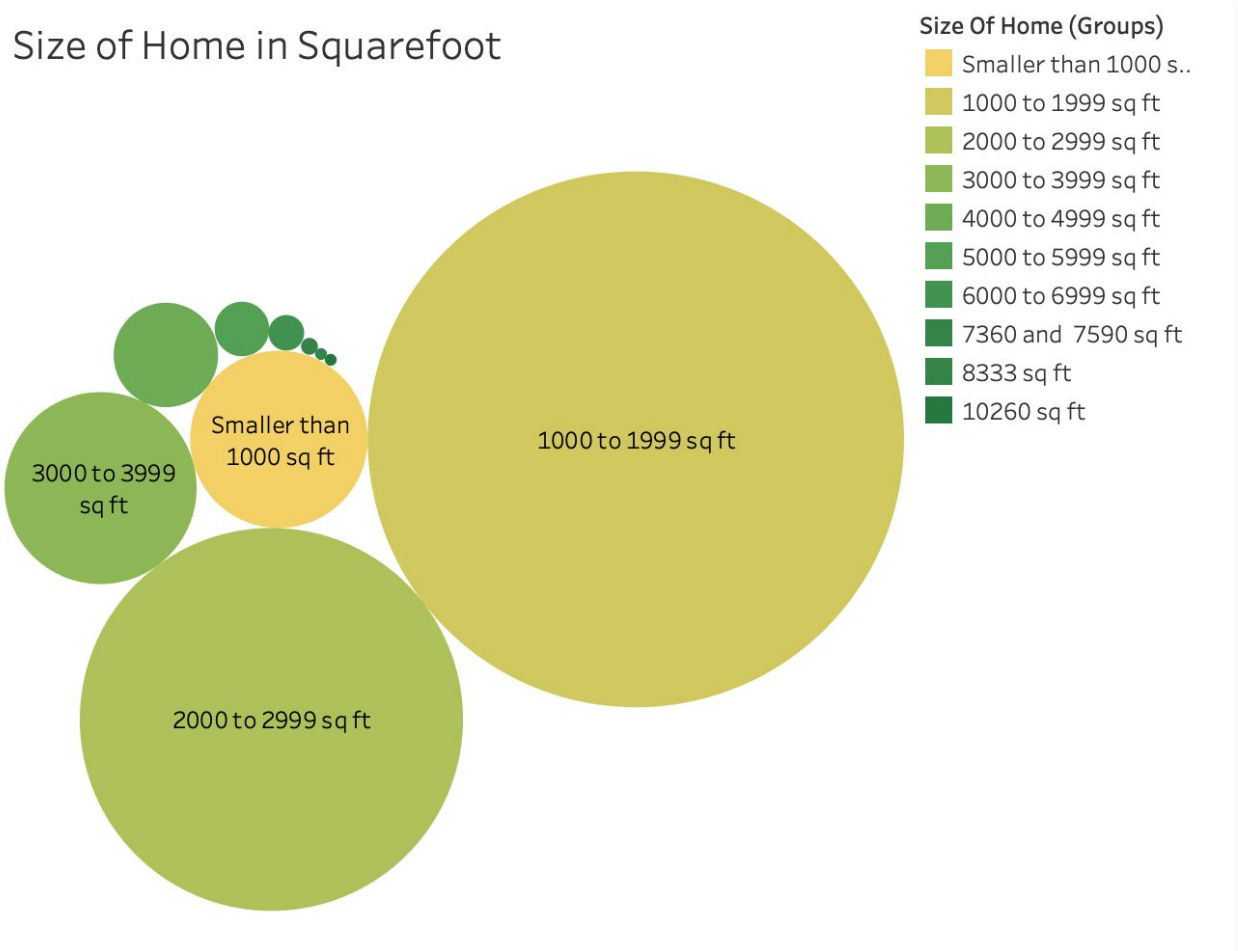
The data

- Dataset backcasts estimated modeled savings for completed projects in the US state of New York from 2007 to 2012
- Projects are part of the Home Performance with ENERGY STAR® Program under Residential Existing Homes (One to Four Units)
- The focus is on Predicted First Year Savings for Energy Efficiency Measures during the mentioned period
- Analysis involves comparing estimated savings against normalized values using an open-source energy efficiency meter

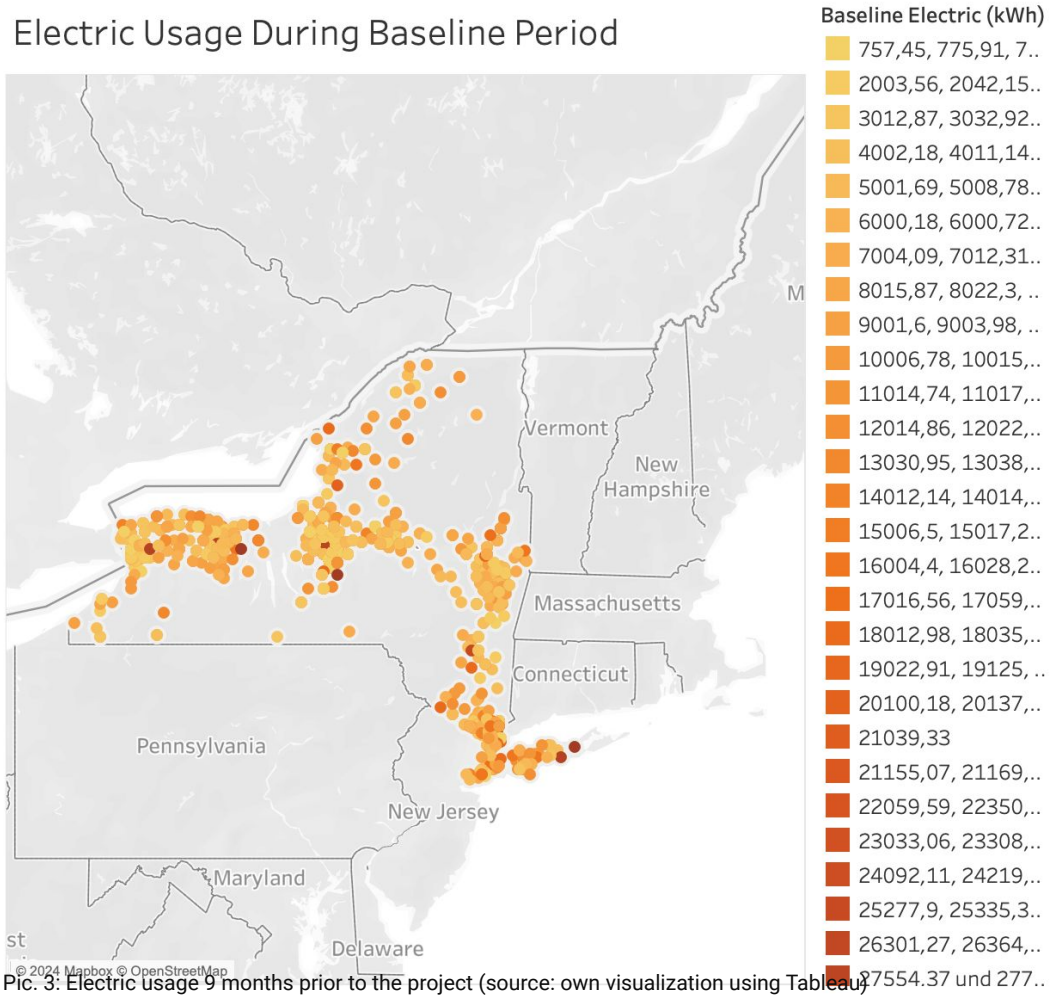
Geographical Distribution of the Projects



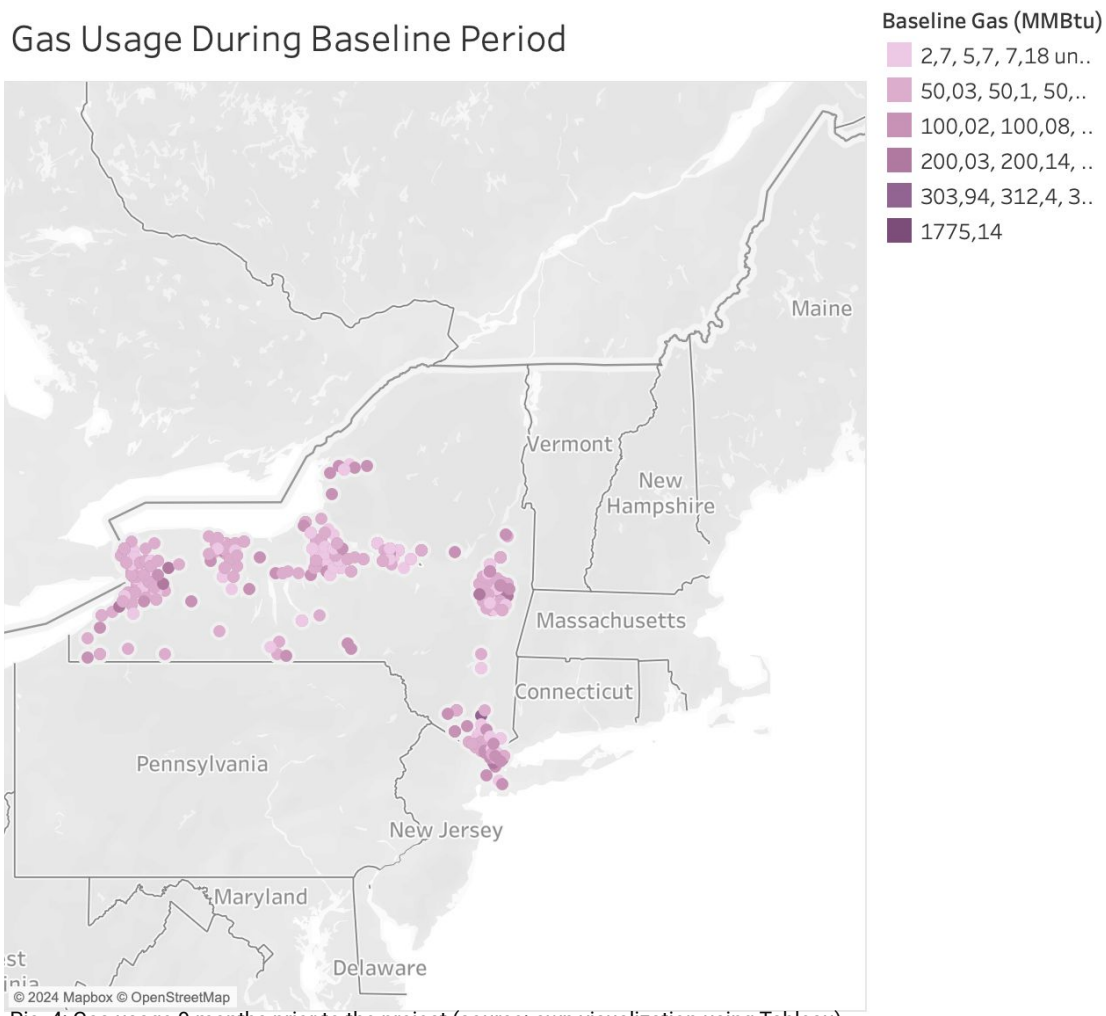
Pic. 1: Geographical Distribution of Projects (source: own visualization using Tableau)



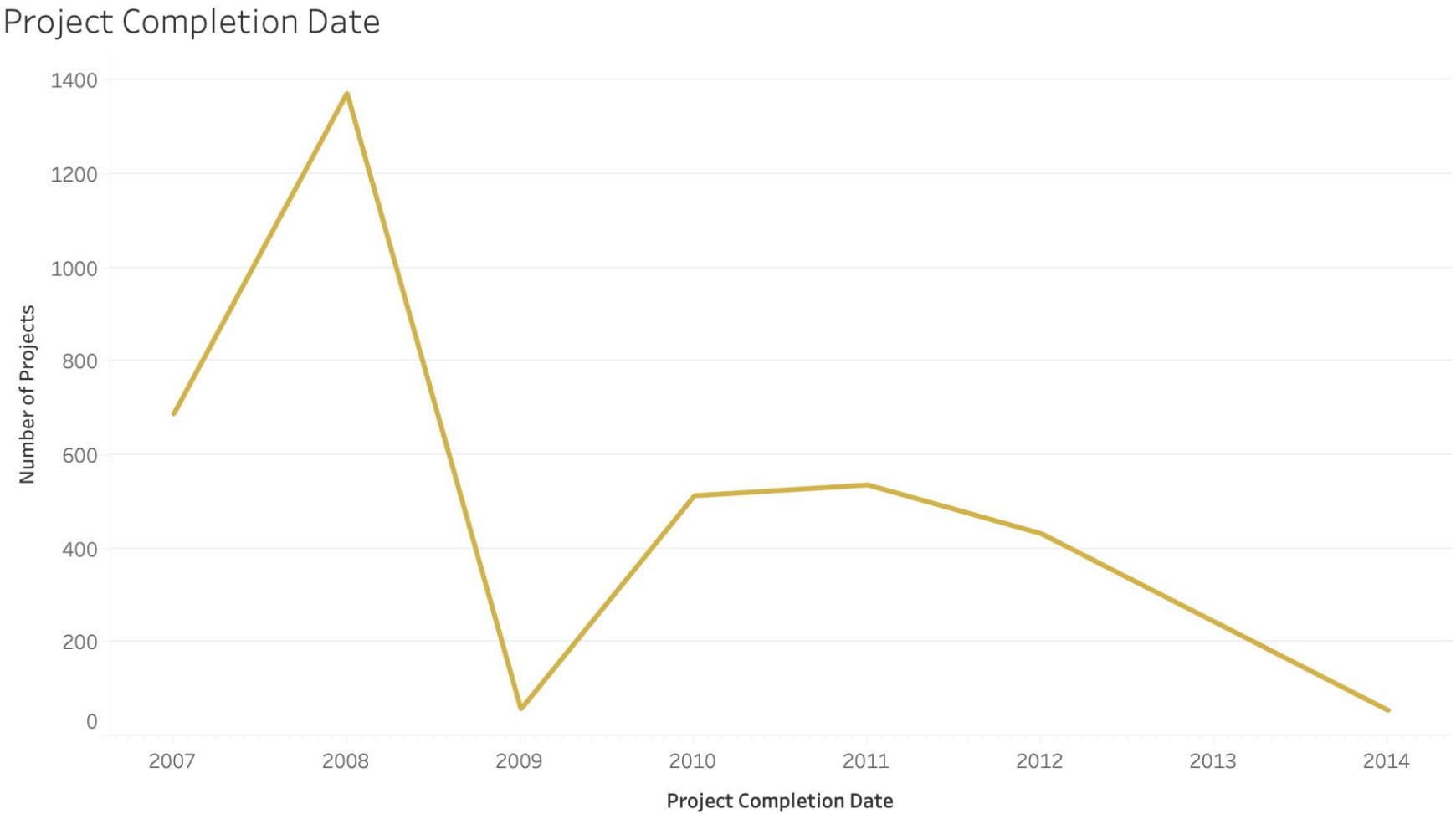
Pic. 2: Size of Home in Squarefoot (source: own visualization using Tableau)



Pic. 3: Electric usage 9 months prior to the project (source: own visualization using Tableau)



Pic. 4: Gas usage 9 months prior to the project (source: own visualization using Tableau)



Pic. 5: Project Completion Date (source: own visualization using Tableau)

Goals of the project

- Primary goal: Develop machine learning models for predicting the gas and electricity usage after the project implementation → to later be able to calculate savings
- Predict total project costs for future projects

Predicting Reporting Gas

Linear Regression Model Performance

- Data Used:
  - Features (X): climate_zone, weather_station, size_of_home, number_of_units, year_home_built, total_project_cost, contractor_incentive, total_incentive, amount_financed_through_program, baseline_gas
  - Target (y): reporting_gas
- Error Metrics:
  - Mean Squared Error: 317.10
  - R-squared: 0.95
- Model Evaluation:
  - Training Set R2: 0.92
  - Test Set R2: 0.95

Predicting Reporting Electricity

Random Forest Model Performance

- Data Used:
  - Features (X): climate_zone, weather_station, weather_station-normalization, size_of_home, number_of_units, year_home_built, total_project_cost, contractor_incentive, total_incentive, amount_financed_through_program, baseline_electric, baseline_gas, central_hudson, consolidated_edison, lipa, national_fuel_gas, nyseg, orange_and_rockland, rochester_gas_and_electric
  - Target (y): reporting_electric
- Error Metrics:
  - Mean Squared Error: 2,557,843.63
  - R-squared: 0.90
- Model Evaluation:
  - Training Set R2: 0.98
  - Test Set R2: 0.90

Predicting Total Project Cost

Random Forest Model Performance

- Data Used:
  - Features (X): climate_zone, weather_station-normalization, size_of_home, number_of_units, year_home_built, contractor_incentive, total_incentive, amount_financed_through_program, baseline_gas, baseline_electric, reporting_electric, reporting_gas, central_hudson, consolidated_edison, lipa, national_fuel_gas, nyseg, orange_and_rockland, rochester_gas_and_electric
  - Target (y): total_project_cost
- Error Metrics:
  - Mean Squared Error: 1,704,874.05
  - R-squared: 0.92
- Model Evaluation:
  - Training Set R2: 0.98
  - Test Set R2: 0.92

Next steps

- **Extend data to cover all 12 months:** Enhance analysis by including baseline and reporting values for the entire year, capturing the impact of energy efficiency projects during crucial winter months.
- **Consider long-term data:** Factor in seasonality, weather conditions, energy market and other variables for a more precise understanding of gas and electricity usage patterns over time.
- **Enable comprehensive analysis:** Broaden the dataset to explore nuanced contributions of various factors to fluctuations in energy consumption, fostering a more informed approach to energy efficiency initiatives.

Conclusions

- Project generated successful models for predicting energy and gas usage nine months post-project

  → enables accurate calculation of savings by comparing post-project usage with baseline values

  → Provides economic insights to incentivize homeowner participation in energy efficiency projects
- Facilitates stakeholder decision-making by accurately predicting total project costs

  → Promotes sustainable investments in energy efficiency for long-term benefits

Thanks!

Do you have any questions?

Feel free to contact me on GitHub:

https://github.com/simfi2023

Resources

All the graphs were independently crafted using **Tableau** to ensure a personalized and insightful visual representation.

For access to the complete Tableau data, kindly refer to the link provided below.

[Link to Tableau Data: **TBD**]

Additionally, other images used in the presentation are sourced from the open-access library at **pexels.com.**

The presentation template was created by **Slidesgo**, and includes icons by Flaticon.

Other information sourced from:

German BMZ (https://www.bmz.de/en/issues/climate-change-and-development/energy-and-climate#:~:text=The%20energy%20sector%20has%20a,need%20more%20and%20more%20energy, last retrieved 29.01.2024)

European Council (https://www.consilium.europa.eu/en/infographics/energy-prices-2021/#:~:text=The%20price%20of%20energy%20in,Ukraine%20had%20an%20aggravating%20effect., last retrieved 29.01.2024).