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Energy Informational Tool

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Energy Informational Tool

is an online platform that compiles and displays energy usage data from Duke buildings.

Problem

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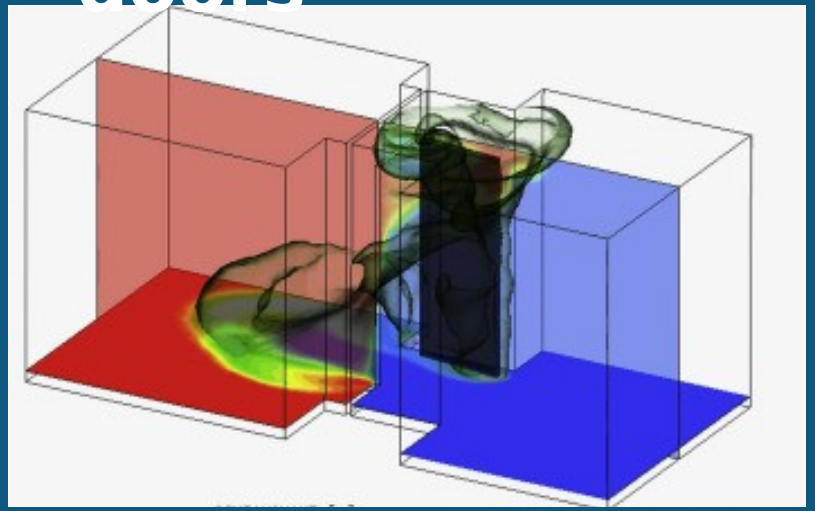
- **Data Accessibility**

- **Energy waste via doors**



Motivations

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Energy Informational Tool

- Transparency of macro-scale energy usage
- Unified platform

Engineering

- Demonstrate micro-scale modular applications

Available Data

- Historic electricity and steam use
  - 10 years, monthly
- Current steam, hot water, and chilled water use
  - 15-minute intervals, updated daily
  - Going back 9 months

Raw Data

Building	Timestamp	Consumption (ft^3)
Gilbert-Addams	9/8/22 4:00	34.2
Gilbert-Addams	9/8/22 4:15	35.8
Gilbert-Addams	9/8/22 4:30	28.04
Gilbert-Addams	9/8/22 4:45	37.03
Gilbert-Addams	9/8/22 5:00	28.3
Gilbert-Addams	9/8/22 5:15	38.32
Gilbert-Addams	9/8/22 5:30	44.84
Gilbert-Addams	9/8/22 5:45	43.98

Our Steam Model

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- Purchased historical weather data for Durham, NC
- Merged it with our building steam consumption data
- Used RStudio to create linear regression model identifying predictors of relevance
  - Temperature, UV, and Apparent

Regression

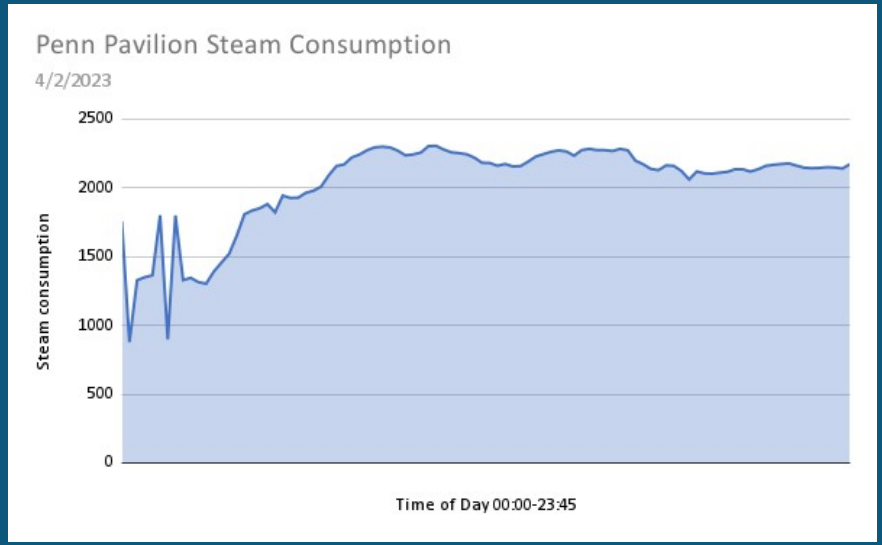
```
Call
lm(formula = consumption ~ temperature + feels_like + uv, data = ga_data)

Residuals:
    Min      1Q  Median      3Q     Max
-629.08 -162.37   -7.12  157.76  673.38

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 1395.901     17.234  80.997  < 2e-16 ***
temperature  -31.176      1.671 -18.660  < 2e-16 ***
feels_like    10.128      1.443   7.017 2.39e-12 ***
uv            41.182      1.316  31.298  < 2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 221.8 on 12356 degrees of freedom
  (3090 observations deleted due to missingness)
Multiple R-squared:  0.4207,    Adjusted R-squared:  0.4206
F-statistic:  2991 on 3 and 12356 DF,  p-value: < 2.2e-16
```

Our Steam Model cont.

- Created web scraping script for weather forecasts
- Predicted steam consumption with historical and weather data
- Use case for information tool platform

Mon 01	69°/46°	Partly Cloudy	7%	WSW 13 mph
Tue 02	70°/49°	Partly Cloudy	18%	WSW 12 mph
Wed 03	72°/50°	Mostly Sunny	12%	W 10 mph

weather.com



Website

Goals:

- Clear and direct displaying of multiple data inputs
- Fidelity and utilization akin to Princeton's Energy Usage Website

Improvements:

- Improve UI/UX for easier future integration

SCAN ME

Website

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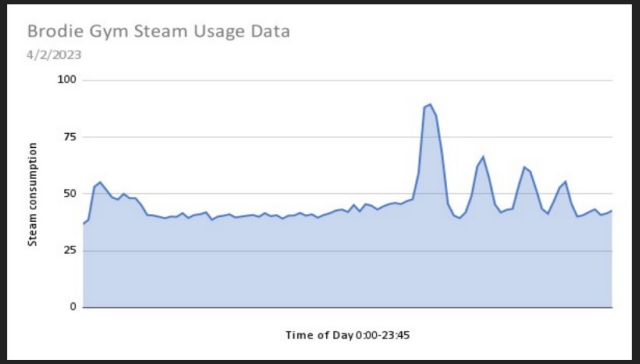
Energy Information Tool

We divided our data and models into building types. Click on one of the buttons to see energy usage data for each building group.

RESIDENTIAL | ACADEMIC | ATHLETIC | OTHER

Athletic



Budget & Materials

Item	Quantity	Cost per unit ($US)
Platinum RTD Sensor - PT100	6	16.50
PT100 RTD Temperature Sensor Amplifier - MAX31865	6	14.95
FS3000-1015 Air Velocity Sensor Breakout	3	59.95
Flexible Qwiic Cable - Breadboard Jumper	3	1.60
Micro SD Card Breakout	3	7.50
Micro SD Card	3	6.00
Arduino Uno	3	28.50

Item	Quantity	Cost per unit ($US)
Proto/Breadboard	3	6.75
1” 80/20 Aluminum Extrusions	7 ft	2.76
9V Battery	3	2.62
Barrel Jack	3	3.50
Wifi Module (ESP8266)	3	7.50
80/20 1/4-20 x 0.5” Button Head Socket Cap Screw with Steel Slide-in T-Nut	25	0.68
80/20 Aluminum 2 Hole Inside Corner Bracket	10	4.41
	Total	**631.82**

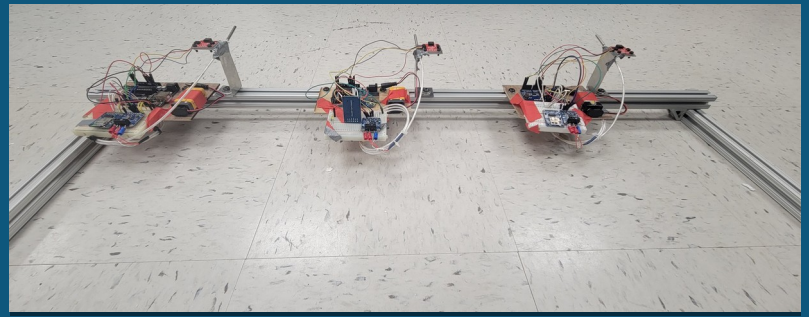
Final Progress - Live Data

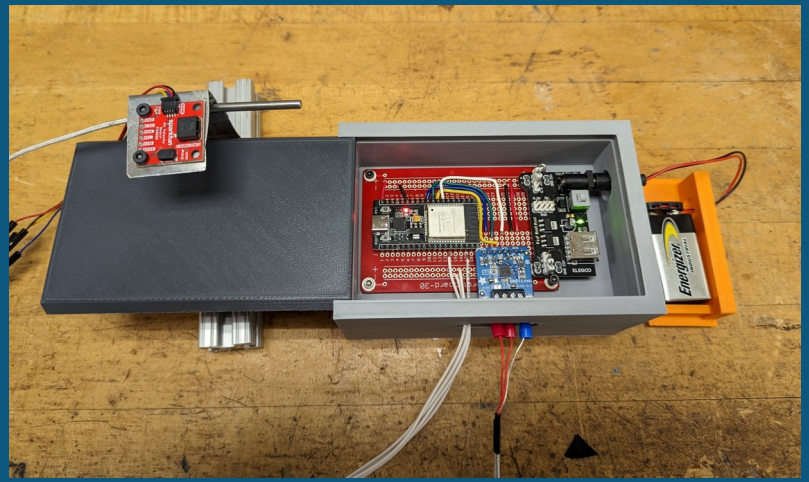
Goals:

- Understand energy loss
  - Numerical model
- Demonstrate future compatibility for the website

Improvements:

- Increase model robustness
- Better real-time integration with website





Data Collected

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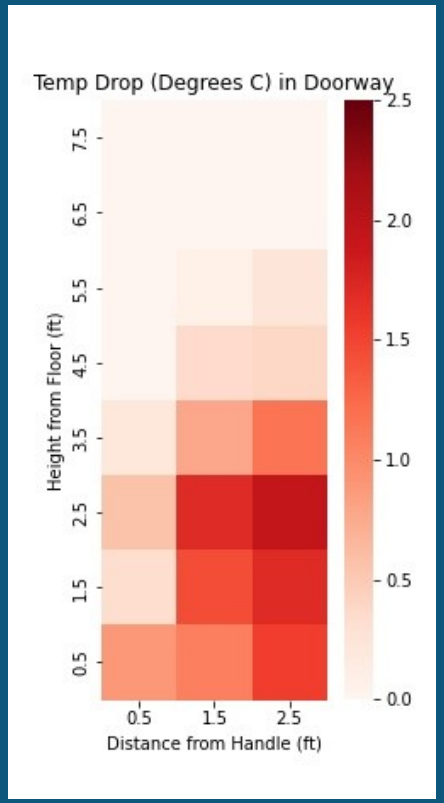
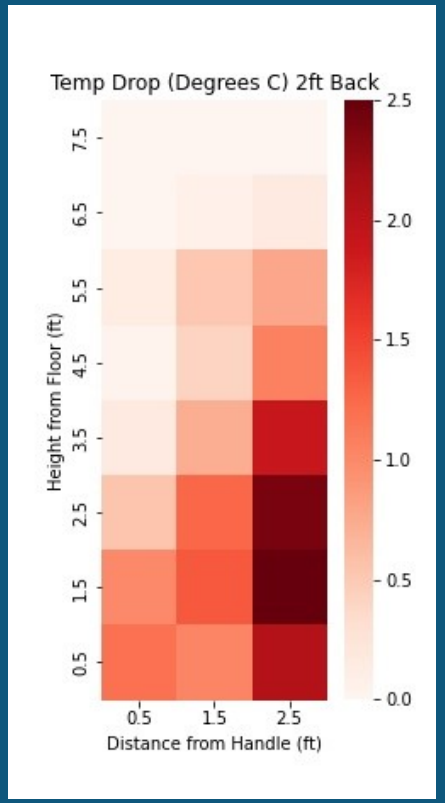
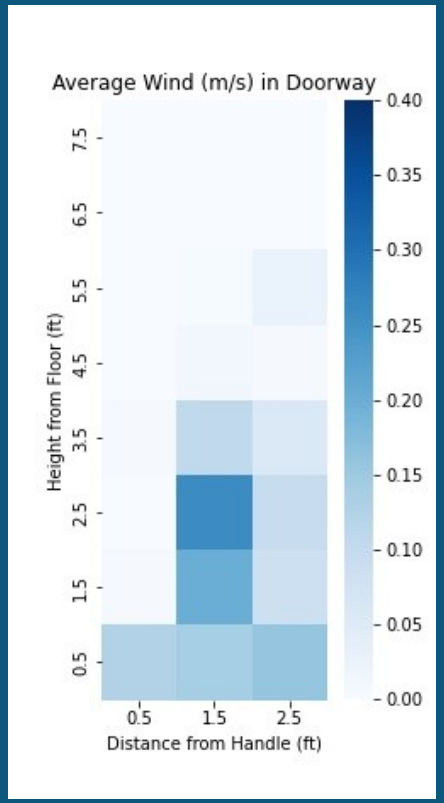
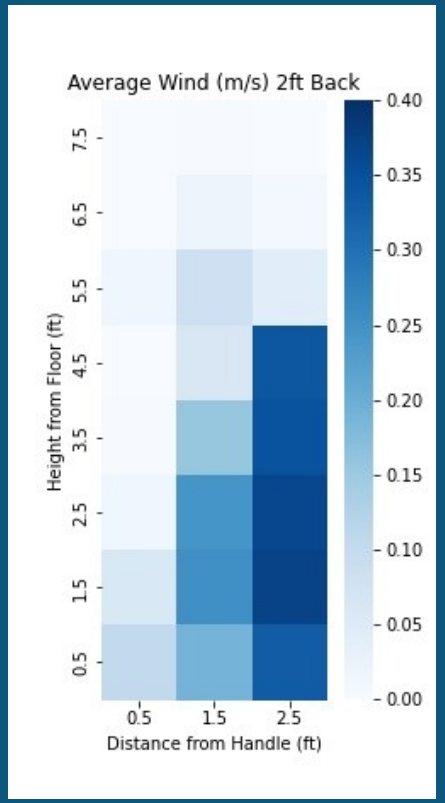
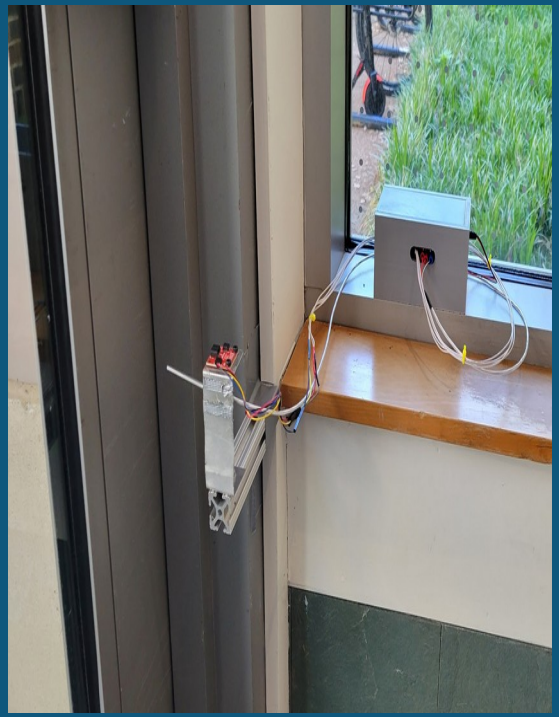








Final Progress - Live Data



Benefits

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Social

- Student groups can access energy data
- Important for policy-making
- Increases awareness of steam usage and heating patterns in student body

Environmental

- Promotes more conscientious energy-use in the student body
- Wasted energy from doors = 7 Watt hrs for 20 seconds open

Market

- Helps Duke save money and energy
- Proposed solutions will integrate efficiency with accessibility

Promotion

- Reached out to Duke Environmental Union
  - In addition to energy/environment- oriented ***student groups*** to get our tool publicized
- Talked to DSG member → **Green Devils** to carry on the work potentially
  - Paid student interns
  - Managed by Sustainable Duke
- **Future**: Contacting energy usage website teams at other campuses to

Results

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Informational Tool Platform

- Accessible, presentable website
- Displayed energy use information for different building types at Duke
- Promoted to student body and student groups that work with energy and the environment

Engineering Data Collection

- Constructed a numerical model based on experimental data
- Integrated real-time data with the website tool
- Used collected data to inform campus decisions

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Thank You!