Earth, Wind, Fire

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Hypothesis

The month with the most cold/hot days is the month with the highest (a) residential natural gas consumption and (b) residential electricity consumption.

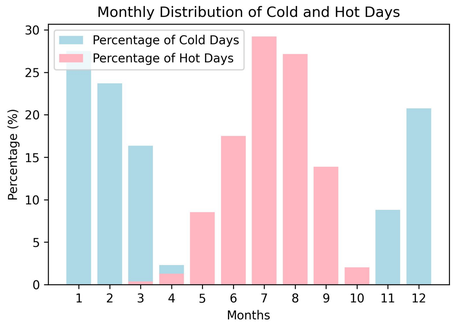
Data

We downloaded min/max daily temperatures and monthly residential natural gas/electricity consumption for the 6 states of New England from 2010-2019 from NCEI and EIA.

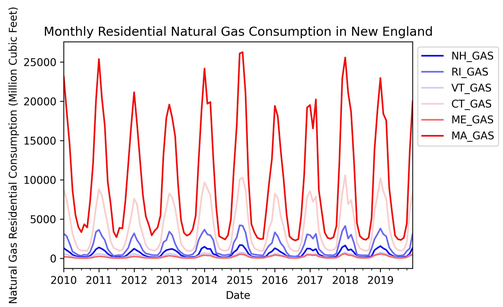
Methodology

- **Hot day:** For every state, we calculated the 75th percentile of all the maximum daily temperatures in that state over the 10 year period. Any max temp above or at the 75th percentile is considered "hot"
- **Cold day:** For every state, we calculated the 25th percentile of all the minimum daily temperatures in that given state over the 10 year period. Any min temp below or at the 25th percentile is considered "cold"

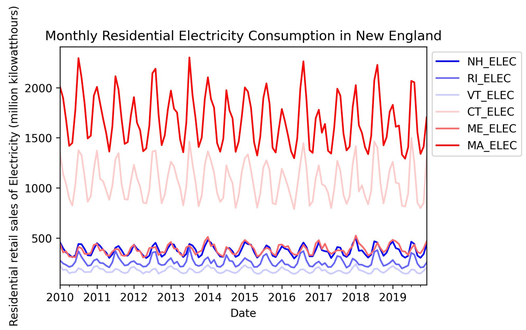
For every state, we summed up the number of hot/cold days in every month. The following graph shows that the majority of hot days occur in summer months whereas the majority of cold days occur in winter months.



The following graph shows that gas consumption peaks in the winter and falls significantly in the summer.

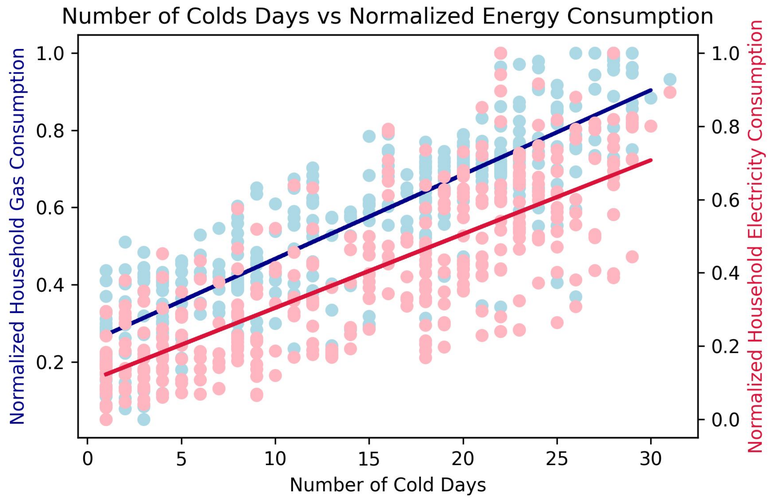


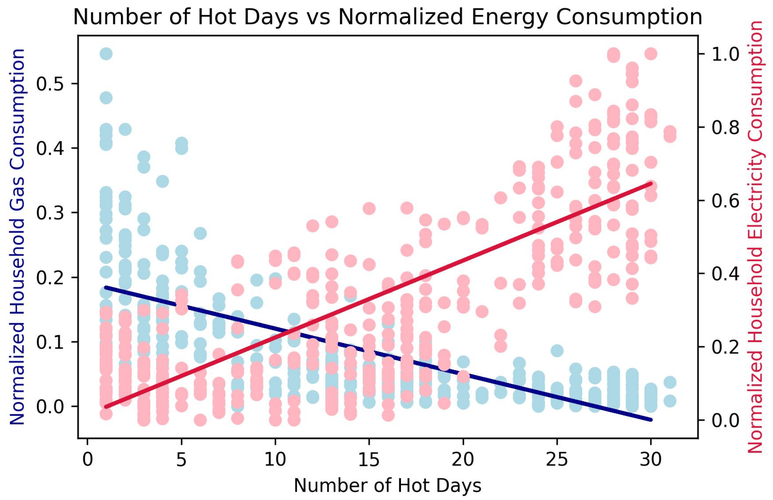
The following graph shows that electricity consumption peaks both in the winter and in the summer.



Simple Regression Models

In the **simple** regression model, the dependent variables - monthly natural gas/electricity consumption - were normalized using a min-max normalization function.





Independent	Normalized Dependent	Pearson's Correlation	P-Value
Number of Cold Days	Gas Consumption	0.855	0.000
Number of Cold Days	Electricity Consumption	0.776	0.000
Number of Hot Days	Gas Consumption	-0.695	0.000
Number of Hot Days	Electricity Consumption	0.790	0.000

There is a stronger correlation between the number of cold days and gas consumption than between the number of cold days and electricity consumption. There is a stronger correlation between the number of hot days and electricity consumption than between the number of hot days and gas consumption.

Multiple Linear Regression Results

We added a dummy variable for each state and season in order to offset discrepancies between different states, such as population size, and due to the fact that hot/cold days cluster by season. We also added interaction variables to consider how the relationship between the number of hot/cold days and natural gas/electricity consumption changes in different seasons.

	Gas		Electricity	
	Coef	P-Value	Coef	P-Value
Number Hot Days	-45.646	0.013	6.282	0.000
Number Cold Days	111.955	0.000	4.705	0.000
Connecticut	1951.502	0.000	607.486	0.000
Massachusetts	8246.966	0.000	1222.635	0.000
Maine	-1798.727	0.000	-75.867	0.000
New Hampshire	-1344.500	0.000	-77.916	0.000
Rhode Island	-446.421	0.081	-202.446	0.000
Vermont	-1707.057	0.000	-280.007	0.000
Fall	1080.617	0.002	340.648	0.000
Spring	1547.332	0.000	344.212	0.000
Summer	492.215	0.530	145.619	0.000
Winter	1781.598	0.016	363.406	0.000
Cold Days*Winter	30.406	0.348	2.991	0.018
Cold Days*Spring	42.155	0.140	2.719	0.015
Cold Days*Fall	39.394	0.368	-1.006	0.556
Hot Days*Summer	23.665	0.453	10.183	0.000
Hot Days*Spring	-26.207	0.527	-5.850	0.000
Hot Days*Fall	-43.104	0.180	1.950	0.120
R-squared	0.714		0.967	

Conclusion

1. There exists a strong **positive** correlation between the number of cold days and both natural gas and electricity consumption. There exists a strong **positive** correlation between the number of hot days and electricity consumption *but* a strong **negative** correlation between number of hot days and gas consumption.
2. An increase in the number of cold days in a month leads to an increase in gas and electricity consumption. An increase in hot days leads to an increase in electricity consumption but a decrease in gas consumption.
3. Electricity consumption is more responsive to a one unit increase in hot days than a one unit increase in cold days; whereas gas consumption is more responsive to a one unit increase in cold days than a one unit increase in hot days.
4. Electricity consumption is more responsive to a one unit increase in cold days during the winter than in the spring. Electricity consumption is more responsive to a one unit increase in hot days during the summer than in the spring.

Limitations

1. Model does not account for population growth, climate change, prices, or humidity, which can impact electricity/natural gas consumption.
2. The interaction variables for gas consumption are not statistically significant for an analysis to be conducted.
3. The negative coefficients for the state dummy variables are not accurate baselines but this is how the regression best fit the data.