Modeling New Hampshire ISO-NE 24-Hour Real-Time Power Prices Based on Seasonal Data

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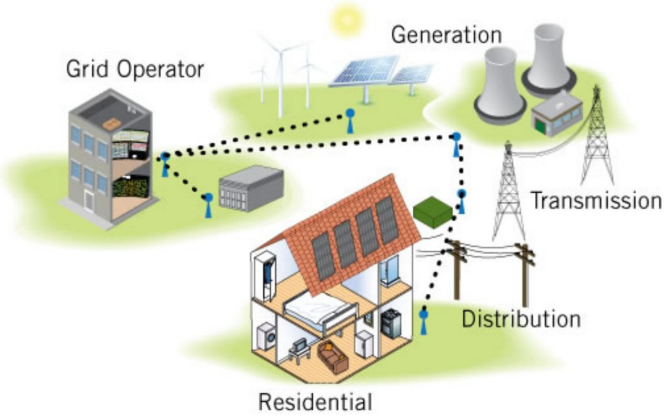
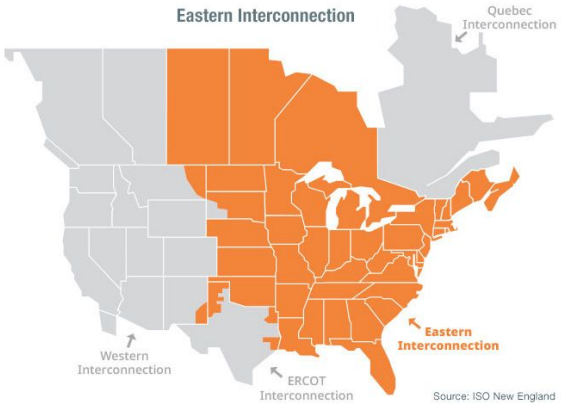
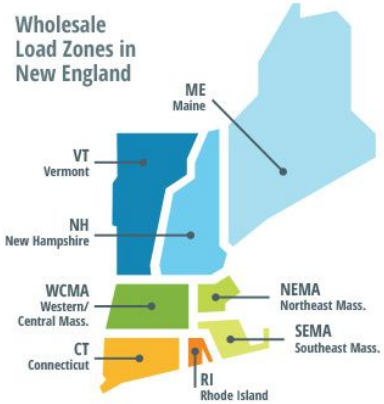
Background

- Power prices are for electricity market
- 3 main zones in United States
- New Hampshire market is partly regulated
  - We focus on regulated ISO-NE Market
- Data used prices on a 24-hour Real-Time Basis
  - Average prices throughout day
  - Prices based on Real-Time Usage

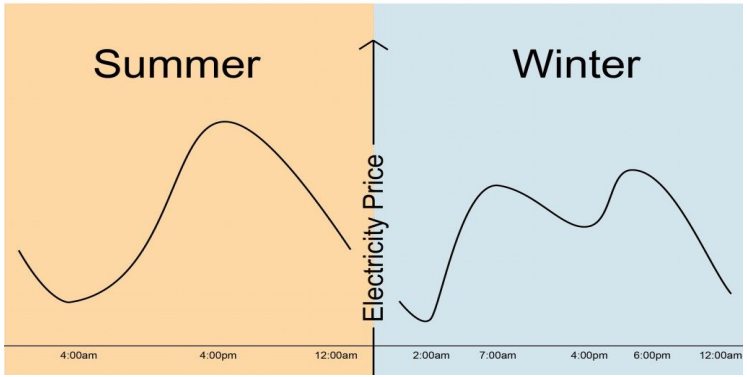


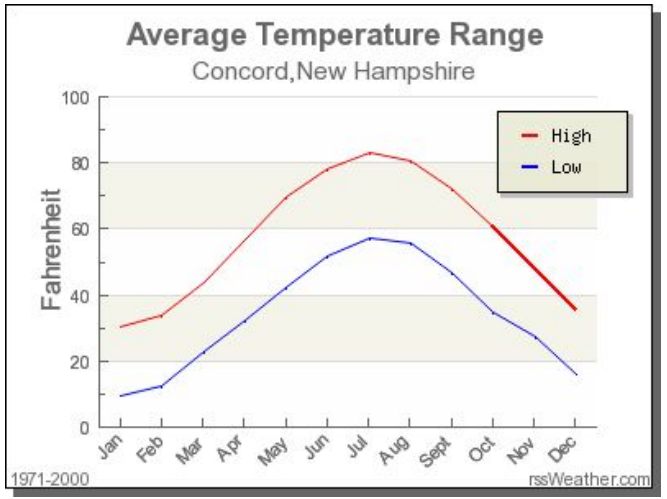




Expectations in Pricing Trends

- Summer and winter will be highest
  - Heating usage during cold New Hampshire winters
  - A/C usage during hot New Hampshire summers
- Outliers exist especially during holidays
- General daily trends involve:
  - Extensive usage during morning and late-afternoon





Graph Approximation Equation

$$Y = A + B*\sin(x) + C*\cos(x) + D*\sin(2x) + E*\cos(2x)$$

MATLAB Code

y = [48.89, … , 21.76];	➜	Lists 146 energy prices corresponding to each week after Jan 1st 2017
x = [1:146]';	➜	x from 1 to 146 (representing each week starting Jan 01 2017
x1 = sin ((2*pi/52)*x);	➜	[sin(x)]
x2 = cos ((2*pi/52)*x);	➜	[cos(x)]
x3 = sin ((4*pi/52)*x);	➜	[sin(2x)]
x4 = cos ((4*pi/52)*x);	➜	[cos(2x)]
x5 = ones (146,1);	➜	[column of ones for constant]

➜ *As the prices cycle every 52 weeks (annually) the inside of sine & cosine must be x/52 so the curve fit matches this annual cycle.*

MATLAB Code

X = [x1, x2, x3, x4, x5];	➜	Create new variable, X, containing 1,sin(x),cos(x),sin(2x),cos(2x)
coefficients = (X'*X)\(X'*y)	➜	Matrix division to find coefficients (A,B,C,D,E)
graph = X * coefficients;	➜	graph corresponds to the y values of the approximation graph
plot (x, graph, 'linewidth', 1.5)	➜	Plots x values (0-146) against the graph to produce the sin/cosine curve fit
hold on	➜	*Graph function (not important)*
scatter (x,y)	➜	Plots the actual values from the data

MATLAB Code + Results

xlabel('Weeks starting Jan 2017'); → Labelling the graph

ylabel('Energy price'); → Labelling the graph

Coefficients we got from the equation were:

A = 36.5435

B = -0.1416

C = 14.9648

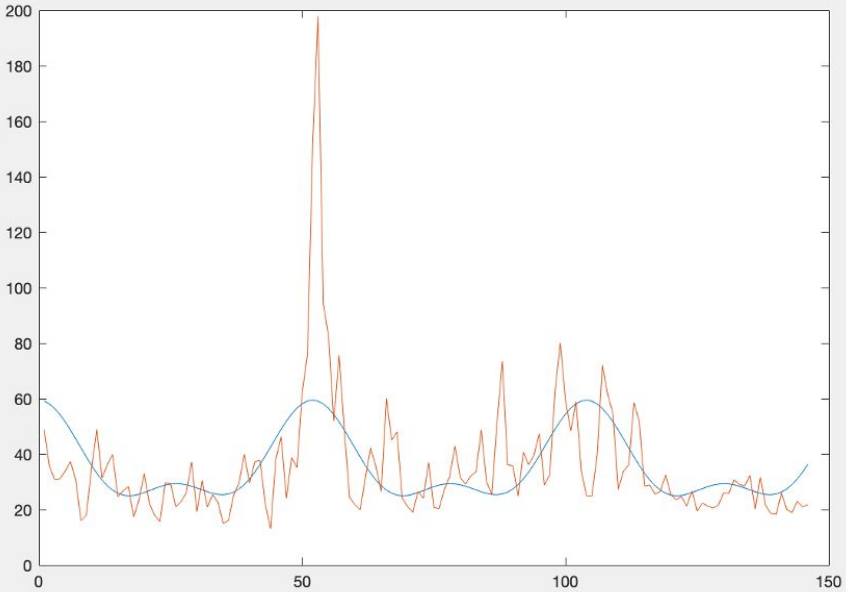
D = 1.1266

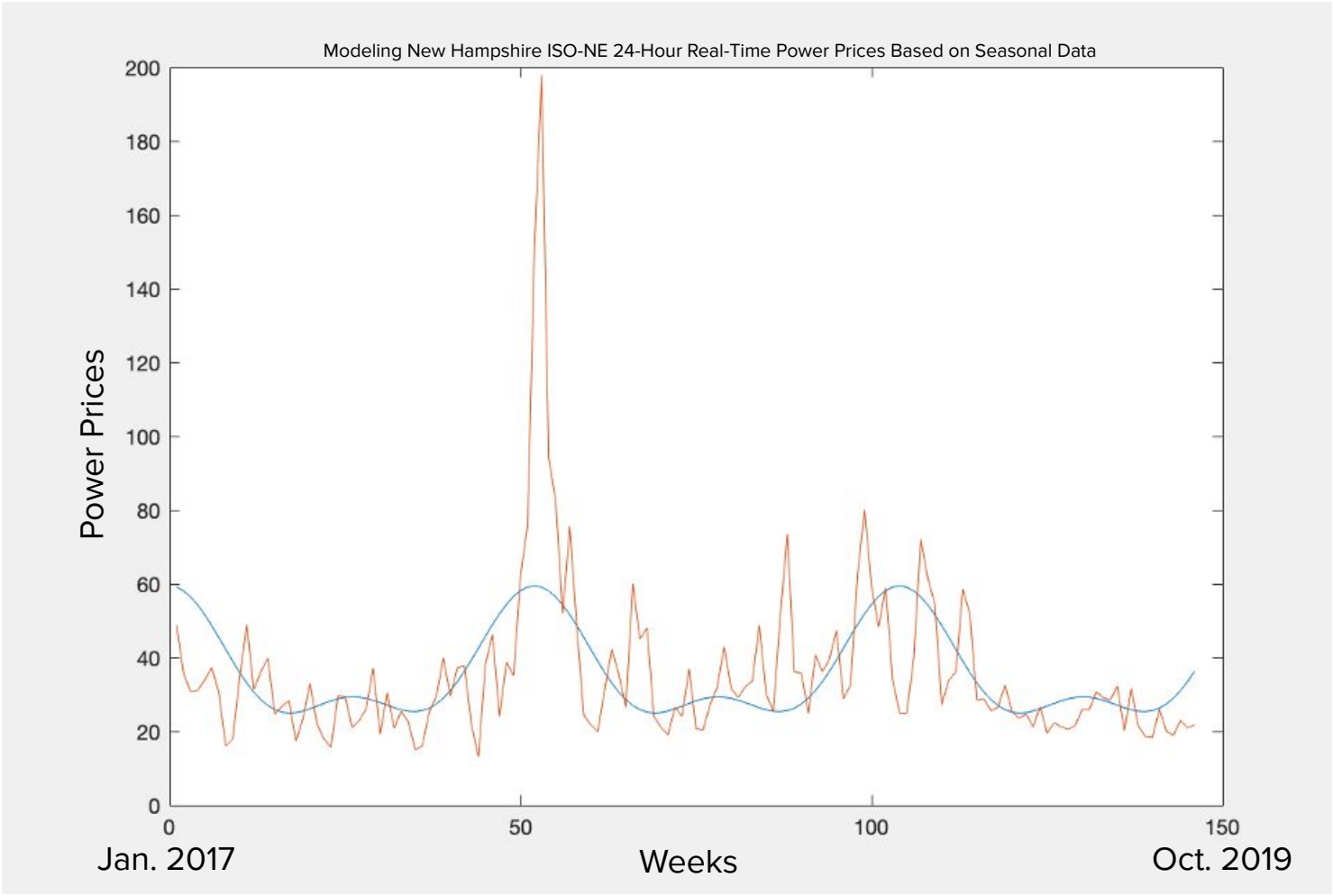
F = 7.7712

Curve Fit Found: **y = 36.5435 - 0.1416*sin(x) + 14.9648*cos(x) + 1.1266*sin(2x) + 7.7712*cos(2x)**

Best Fit Plot (Smoothing Curve)

Plot over the course of January 2017 until October 2019 with a new data point for each week




Modeling New Hampshire ISO-NE 24-Hour Real-Time Power Prices Based on Seasonal Data
Power Prices
200
180
160
140
120
100
80
60
40
20
0
0
50
100
150
Jan. 2017
Weeks
Oct. 2019

Data Trends and Observations

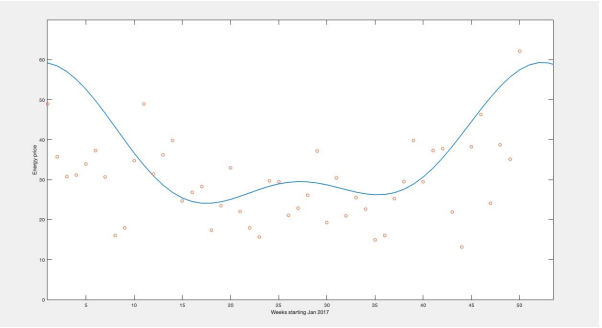
Drastic Increase in Winter Months

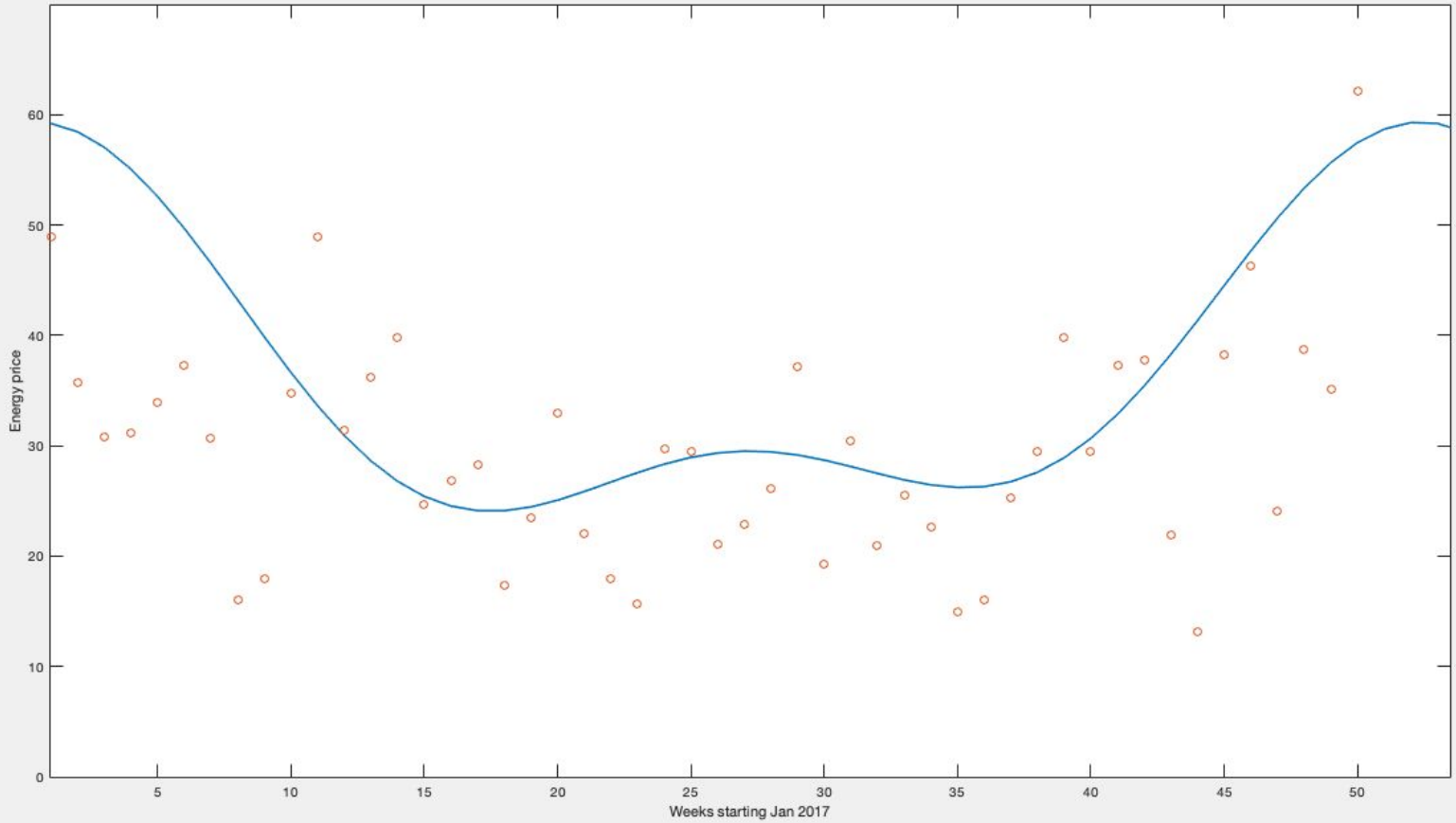
- Increase may be associated with high use of heating appliances and shorter days (more lighting usages)

Slight Increase in Summer Months

- Increase may be associated with use of air conditioning

*graph on right only focused on the first year




Energy price
Weeks starting Jan 2017
0
10
20
30
40
50
60
5
10
15
20
25
30
35
40
45
50