NB’s Renewable Energy

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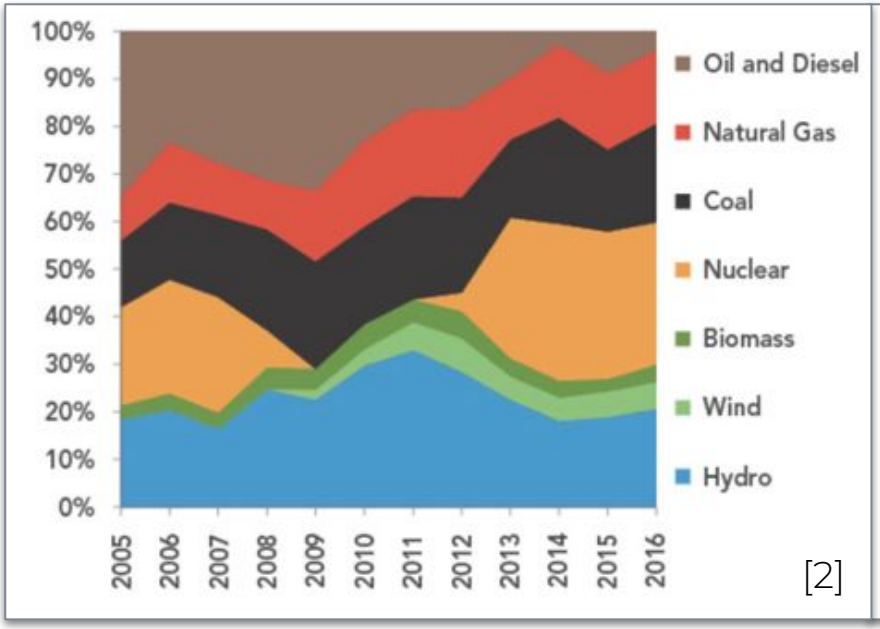
State of Power in NB



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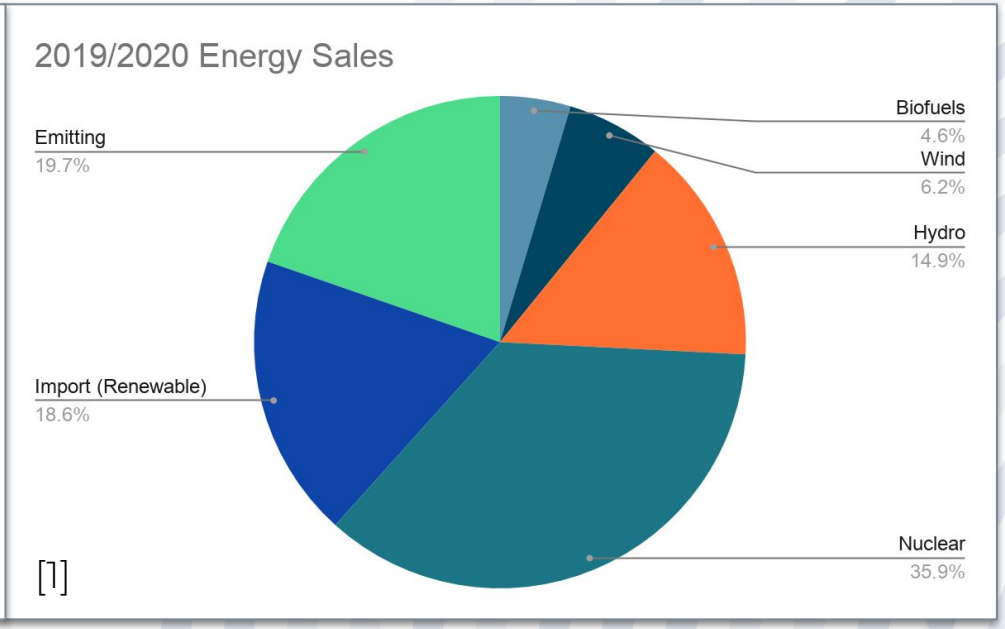

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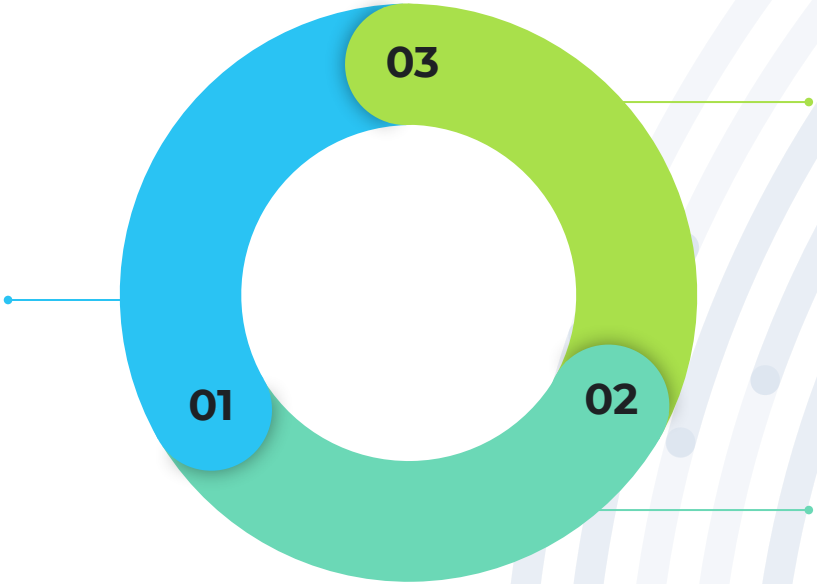
Challenge

- Using past energy usage data, predict the energy consumption across NB
- Minimize the cost to power of all NB's zones
- Maximize the use of renewable power

Design Process

Defining the Problem

.What are we trying to solve? How can we optimize energy distribution and minimize each zone's costs? How does all the pieces of our algorithm work together?



Implementing & Optimizing

Using our predictions, create a greedy algorithm that maximizes the use of non-emitting energies while minimizing the cost of each zone

Predicting and Modelling

Using both polynomial and linear extrapolation, predict the power consumption over the next year and model it to help visualize the accuracy

Technology

Numpy

Used structures to store our and pass data in small amounts to maximize speed and memory efficiency

Pandas

Used to read in excel files in Python environment and store data in data frames

Plotly

Used to plot our past data and our extrapolated (predicted) data

Tracemalloc

A debugging tool used to track the memory usage of our solution over time

Our Solution

Making NB's Energy Cost Efficient & Renewable

Predicting Power (Level 1)

- Used polynomial regression (degree 10) to fit a model for each year of data
- Adjustment value given by linear regression on same month for multiple years
- Polynomial function accounts for seasonal changes, linear accounts for year-over-year trends

Optimizing Power Distribution (Level 2)

- Greedy algorithm approach
- Three stages:
  1. Use as much power local to zone as possible
  2. Loop through zones that still need power, choosing cheapest method of satisfying
  3. Transfer any excess non-emitter power to an external source

$$C_{zone,month}(h) = p_{zone} \cdot h_{zone} + e \times h_{emissive} - b \times h_{non-emissive}$$

Output

- Level 1: Extrapolated data
  - .csv file
    - Zones as columns and months as rows (GWh)
  - Plot
- Level 2: Optimized power
  - .csv file
    - Monthly provincial cost ($/month)
    - Total power consumed (GWh/month)
    - Renewable power used (%/month)
- Memory Usage Plots

Demo

L2 Results

	A	B	C	D	E	F
1		Provincial	Total Pow	Renewable Power Used (%)		
2	Jan	2.98E+08	2096.369	0.420303		
3	Feb	2.85E+08	2005.579	0.439329		
4	Mar	3.02E+08	2120.126	0.415593		
5	Apr	2.94E+08	2070.942	0.425463		
6	May	2.8E+08	1974.754	0.446187		
7	Jun	2.71E+08	1908.845	0.461593		
8	Jul	2.68E+08	1891.637	0.465792		
9	Aug	2.71E+08	1911.928	0.460849		
10	Sept	2.76E+08	1949.35	0.452002		
11	Oct	2.86E+08	2013.171	0.437673		
12	Nov	2.95E+08	2075.053	0.42462		
13	Dec	3.01E+08	2114.712	0.416657		

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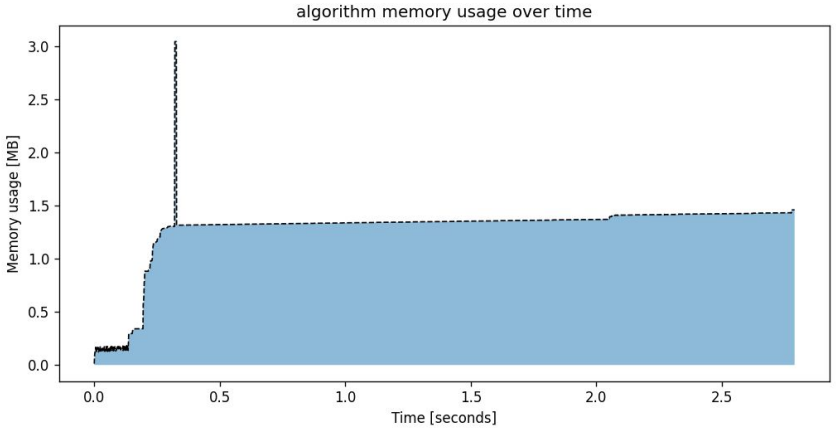
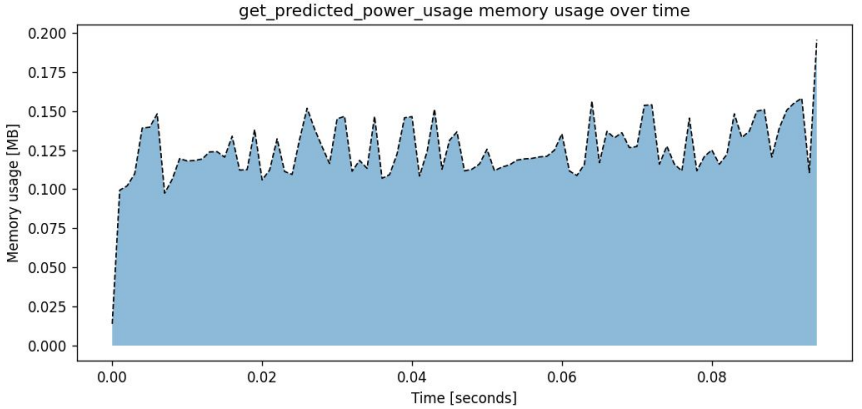
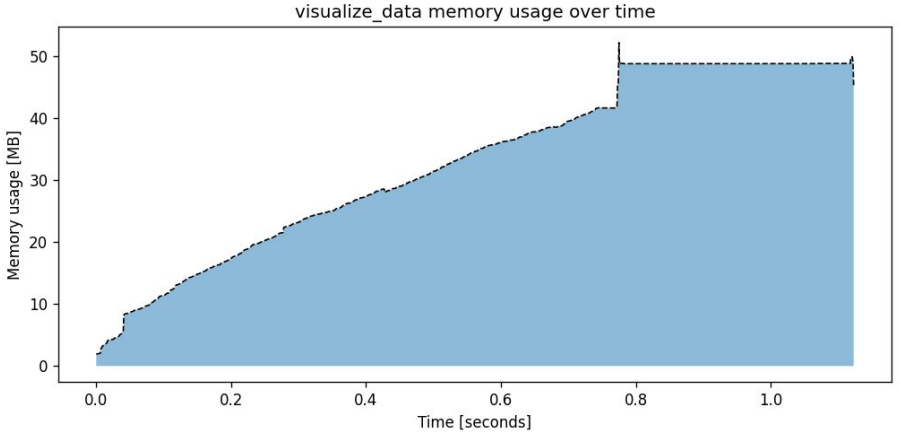
Memory Usage







Next Steps

Time Series

Use more granular/detailed time series data to predict hourly changes in demand instead of monthly

Prediction Model

Use more advanced time series prediction models such as ARIMA, Hidden Markov, or LSTM to predict demand on multivariate data

Detailed Dashboard

Create a user friendly dashboard to show the output of all aspects of a model, improving on simple CSV output

Green Energy

Explore green energy options from neighbouring provinces to potentially pull in renewable energy rather than using emitting energies

Modelling Zones

Model each zone's type of energy use to see which parts of NB lead to higher costs and emission rates. This can then be used to decide where a new power station should go

Black Swan Events

Create a model for emergency situations in which large parts of the province lose power, like the blackout in Texas this month

Questions?

References

[1] N. Power, Our Energy, 2021. [Online]. Available: https://www.nbpower.com/en/about-us/our-energy.

[2] Canada Energy Regulator, Canada's Renewable Power Landscape 2017 - Energy Market Analysis, 2017. [Online]. Available: https://www.cer-rec.gc.ca/en/data-analysis/energy-commodities/electricity/report/2017-canadian-renewable-power/province/canadas-renewable-power-landscape-2017-energy-market-analysis-new-brunswick.html.