INTER STATE ENERGY COMPACT

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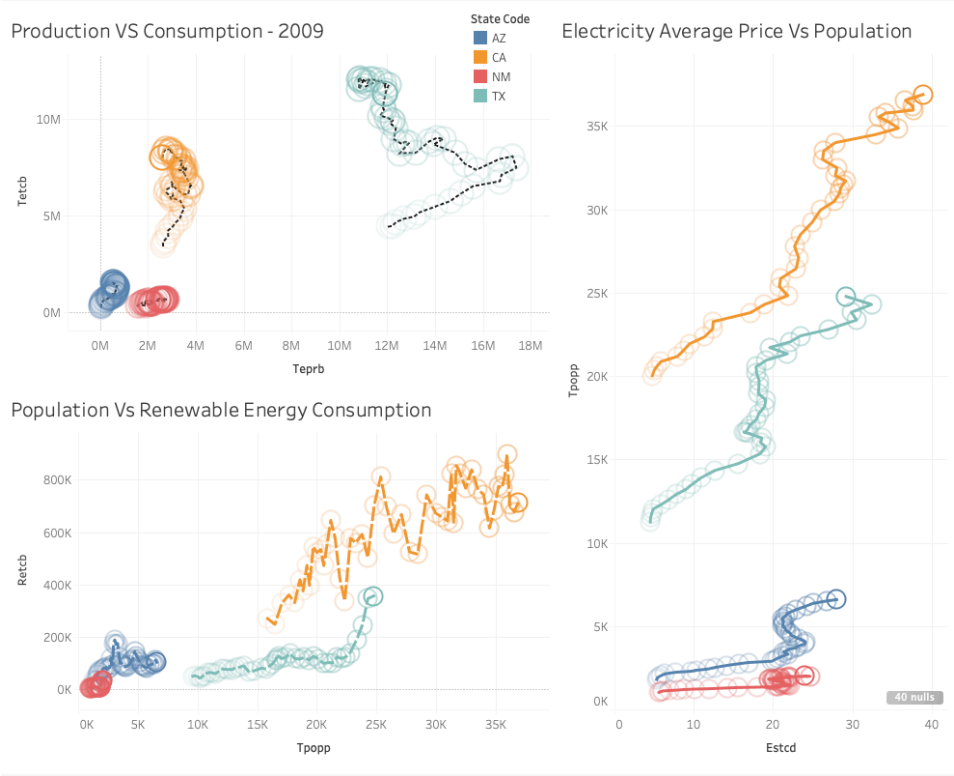
EXECUTIVE SUMMARY

The description of energy profiles of Arizona, California, New Mexica and Texas is provided in the analysis. We compared the total consumption of Renewable vs Non-Renewable resources from 1960 to 2009 to get insight about the consumption of resources in each of the state Year on Year. Then compared energy by different sectors mainly residential, transportation, commercial and industrial to see which sector consumes more electricity in these States.

Now, we compared the Total Energy Consumption and Production over the year to see if there is any trend that we can find from the data. Now, compared Average Electricity Price and Population change over the year and concluded that in all the 4 states, as the population increases, the average price of electricity also increases. At last, compared the Population and Renewable Energy Consumption for all the states.



We started with 605 variables and eliminated the variables that were not important in our analysis. Then we converted the data from long to wide in order to have a better understanding of the variables. We studied about energy scenario in the 4 states in detail and predicted the renewable energy usage for 2025 and 2050.

In future, we will like to use Principal Component analysis for feature reduction and feature elimination to come with a set of variables that are important and build a model based on these variables.

MEMORANDUM

To: Governors
From: Tanay Bhardwaj
Date: 02/16/2020
Subject: Summary of State Profile along with Predictions and Recommendation.

In our analysis we looked at each of the state and analyzed the best energy profile for each one of them.

We find that, Texas has the highest use of Non-Renewable Resources. The recommendation is to reduce the use of Non- Renewable Resources, and at the same time increase investment in Renewable Resources.

California already has a good mixture of both Non-renewable and Renewable Resources. But they should still invest more in Renewable. If any, California needs to cut on the use of Petroleum and Nuclear Energy use.

New Mexico and Arizona need to invest huge sums of money in Renewable Energy. Specially in Geothermal and Solar Energy as they lack in these specific energy production methods.

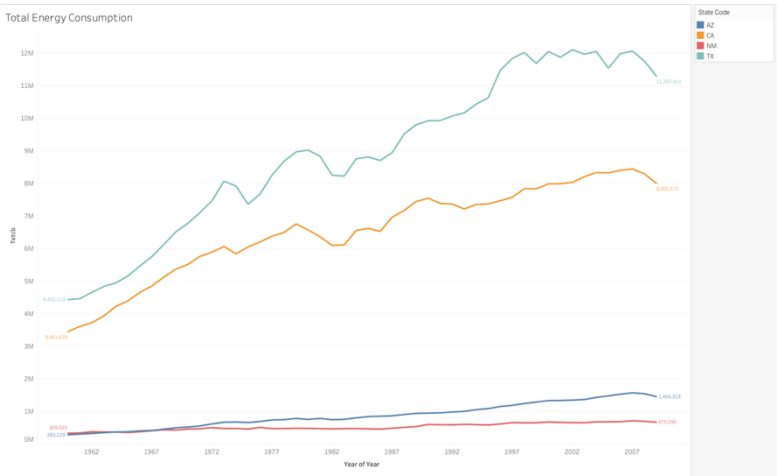
Also, Since the total energy consumption in New Mexico and Arizona is less, we would want the governor to explore a way to produce it in these states but sell it to different state which has got very high energy consumption.

ANALYSIS

At the starting of our analysis, we started with looking at these variables, the total energy Consumption which is sum of the Total Fossil Fuel Consumption and Total Renewable Energy Consumption. The Total Fossil Fuel Consumption is further divided into the following.

- Total Fossil Fuel Consumption
  - Total Coal Consumption
  - Total Natural Gas Consumption
  - Total Petroleum Product Consumption
  - Total Nuclear Energy Consumption

We looked at these variables for all the 4 states. The Total Fossil Fuel Consumption is highest for Texas and lowest for New Mexico. We can see that from the graph shown below.

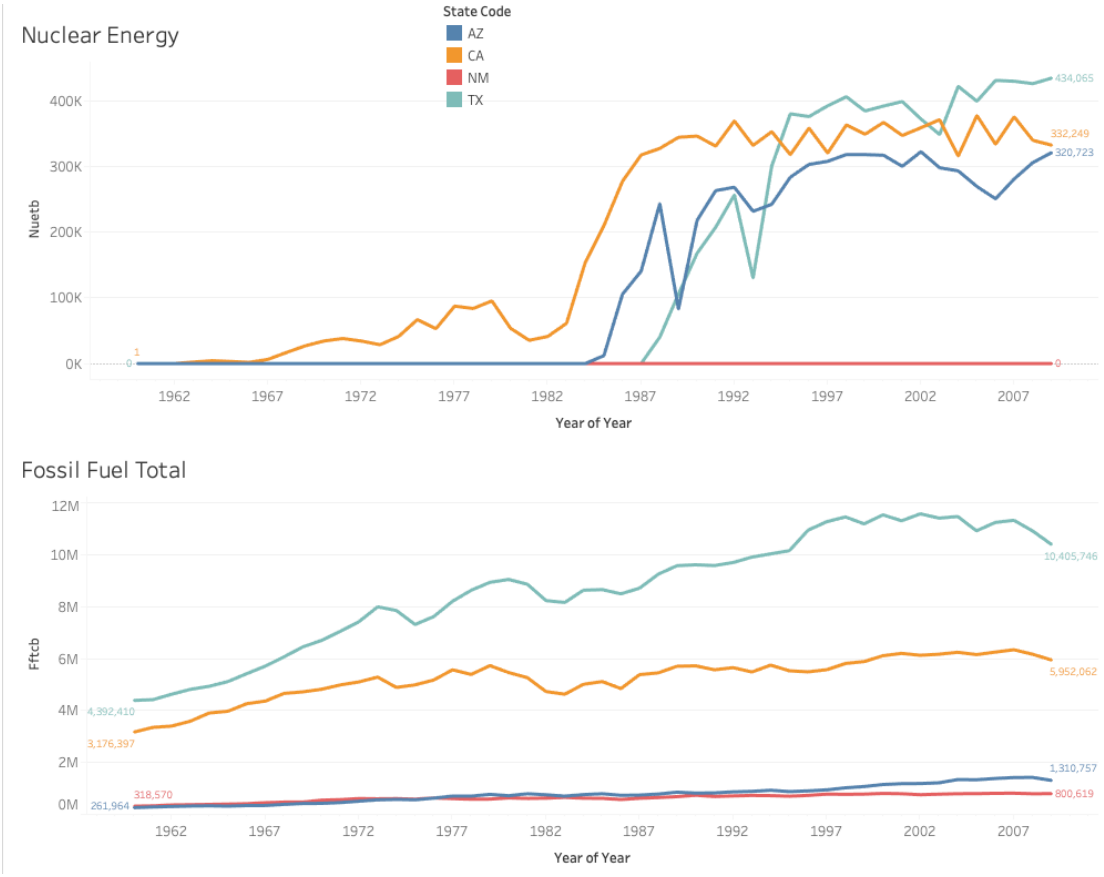


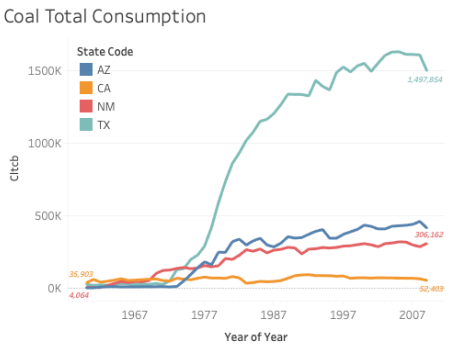
We then looked at the individual variable to understand the reason behind this trend.

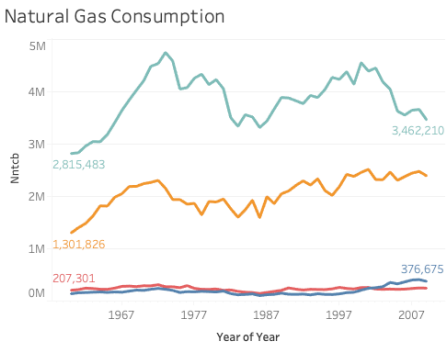
When looking at the Nuclear Energy Consumption, we find that New Mexico has no Nuclear Energy Consumption at all from 1960 till 2009. This could be due to the government policy of no nuclear energy consumption.

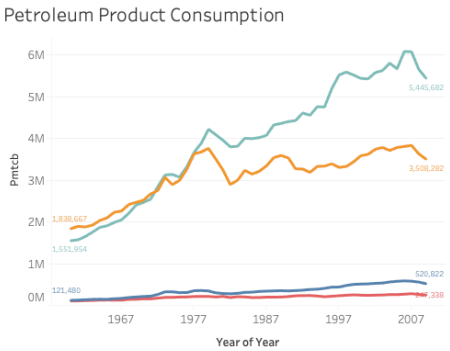
California started using nuclear energy from 1962, before any other state, where as Arizona and Texas started using nuclear energy from early 1980's. In 2009, California and Arizona have almost the same nuclear energy consumption, whereas Texas consumes the most nuclear energy.

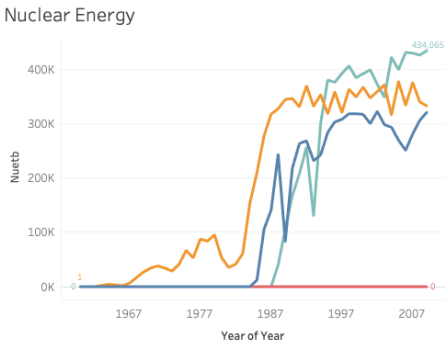
In the 80's the nuclear energy consumption increased rapidly in California, and it increased rapidly in Arizona in mid 80's. In the 90's the nuclear energy consumption reached a saturation level and it did not increase a lot ever since. We can see that from the graph shown below.







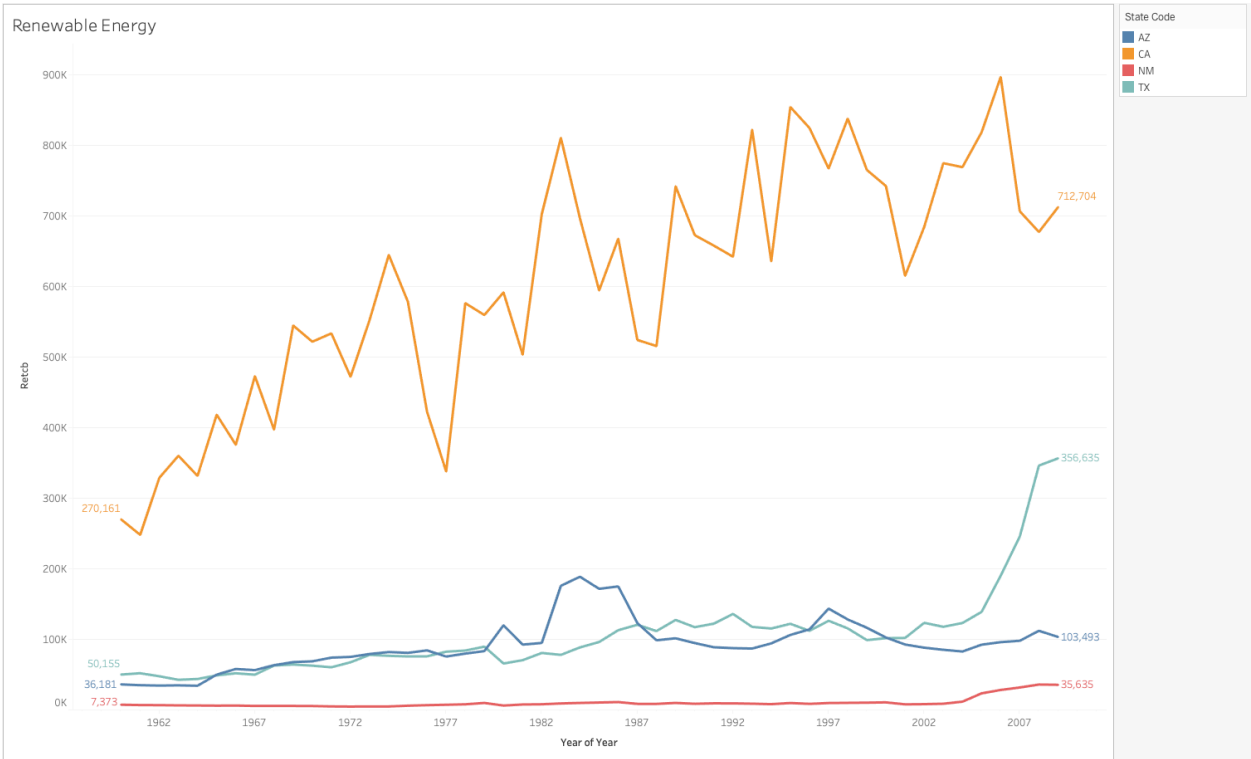




Next, we look at coal, petroleum, natural gas and nuclear energy consumption together. We see that Texas has the highest consumption of all these 4 types of energy, whereas New Mexica has the lowest consumption for all but Coal.

It seems that Texas has the highest consumption of Non-renewable energy sources, whereas New Mexico has the lowest or we can say that New Mexico is cleanest state in terms of Non-renewable energy consumption.

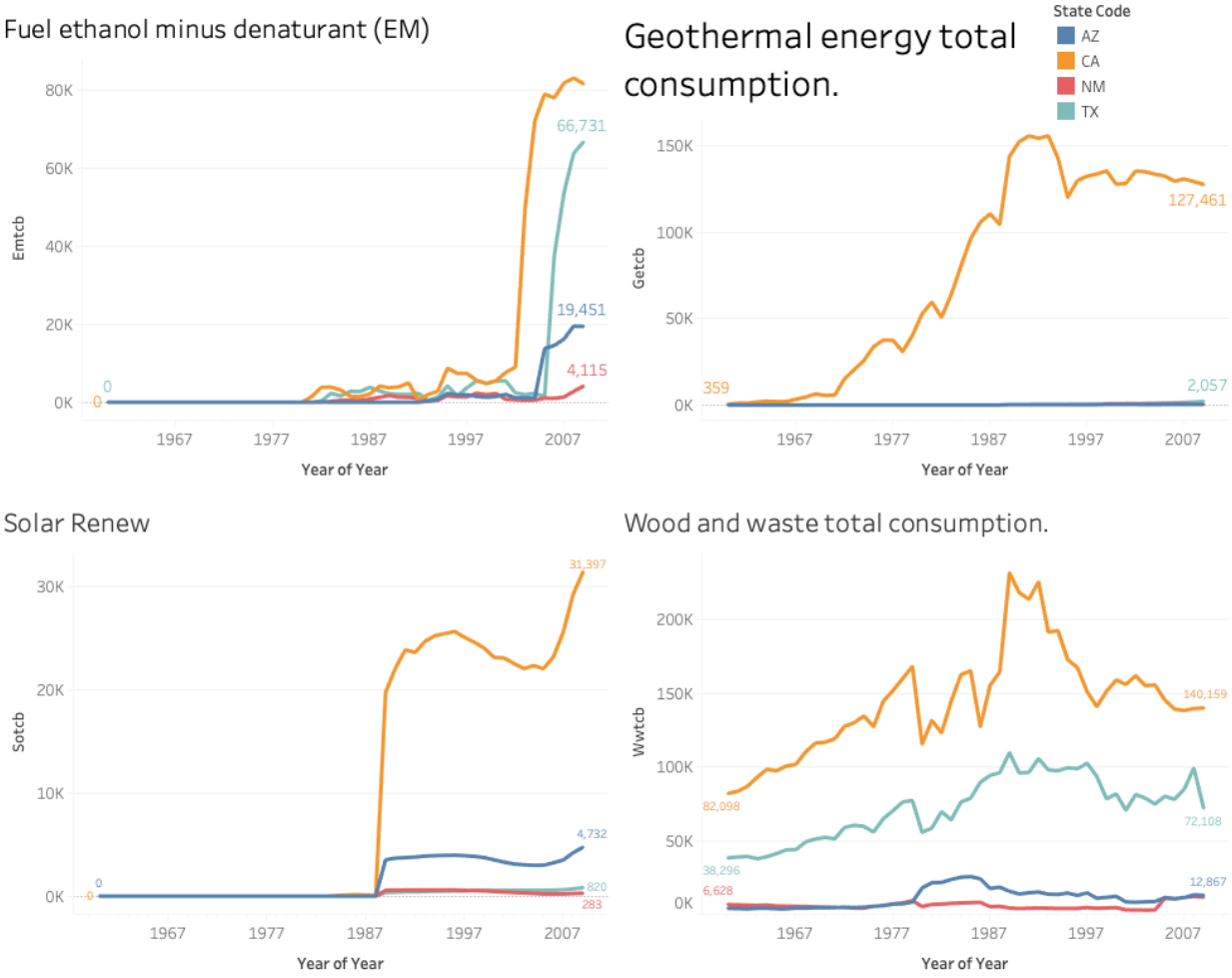
Now, we look at the renewable energy consumption state by state. Again, New Mexico has the lowest consumption of Renewable Energy, whereas California has the highest consumption. In Texas, renewable took off in early 2000's whereas in California, renewable energy had a solid present since early 1960's. There is almost no major change in consumption of it in New Mexico and Arizona. We can see that from the graph shown below.



Now, we looked in depth of renewable energy sources. It was subdivided into

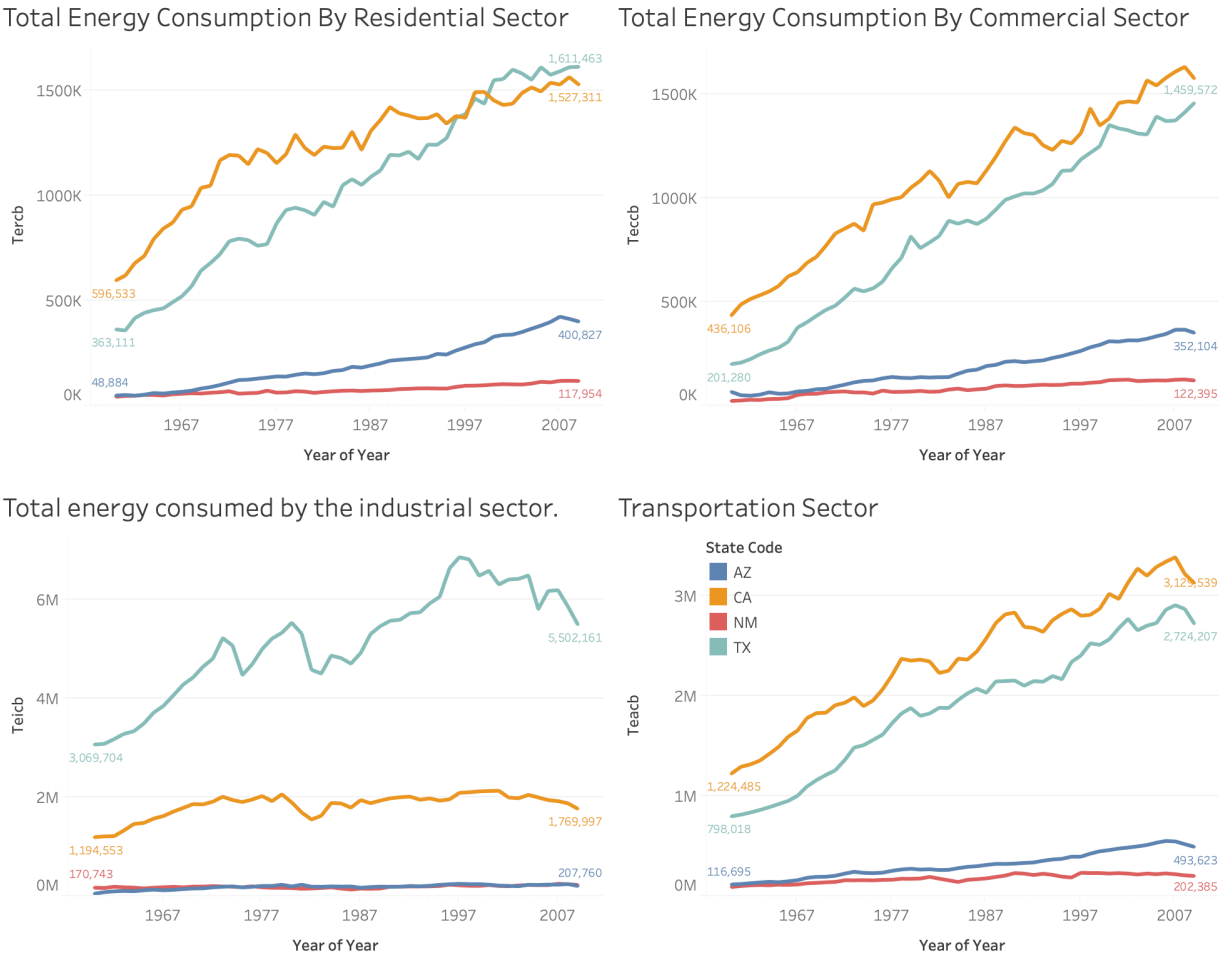
- Fuel ethanol Energy
- Solar Energy
- Geothermal Energy
- Wood and Waste Energy

We decided to omit hydro electricity from our analysis are we did not have enough data for comparing it with the other variables. The fuel ethanol Energy is fuel ethanol minus denaturant.



As we see from the graph above, Fuel ethanol minus denaturant was not widely used till late 1990's. It exploded in the year in early 2000's. Geothermal energy is only present in California whereas Texas and Arizona have almost negligible presence of Geothermal energy consumption. Solar energy came into spotlight in early 90's and California were the first one to adopt it. Arizona, Texas, New Mexico again has almost no presence of Solar Energy. The Wood and waste consumption are highest in California and Texas is a distant second. From this, we can say that California was the first one to adopt to renewable energy whereas all other state lagged in adopting to it. Only Texas was the other state that adopted Renewable energy in some way in mid 2000's

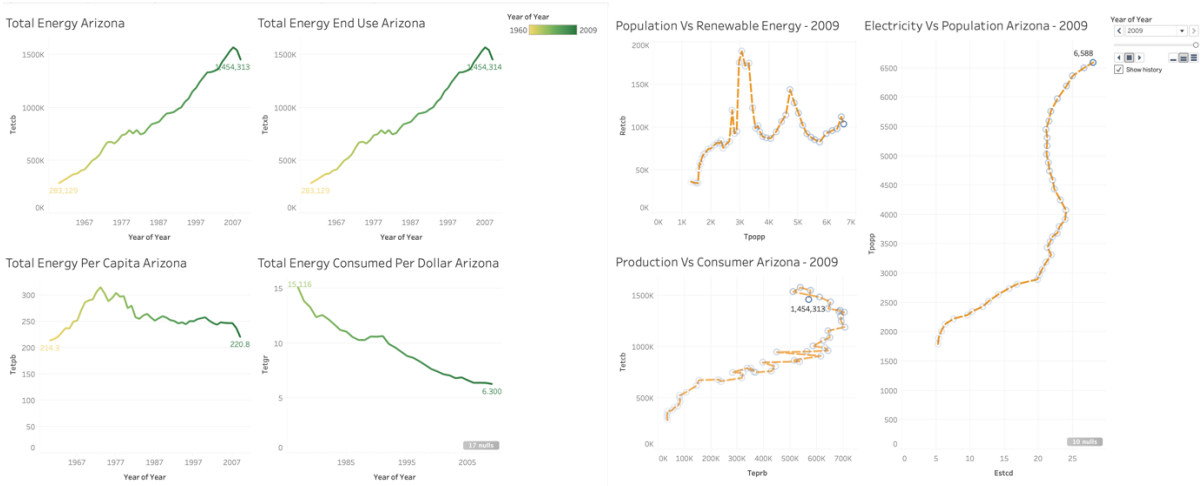
Next, we looked at energy consumption sector by sector. There are mainly 4 sectors. Residential, Commercial, Industrial and Transportation Sector.



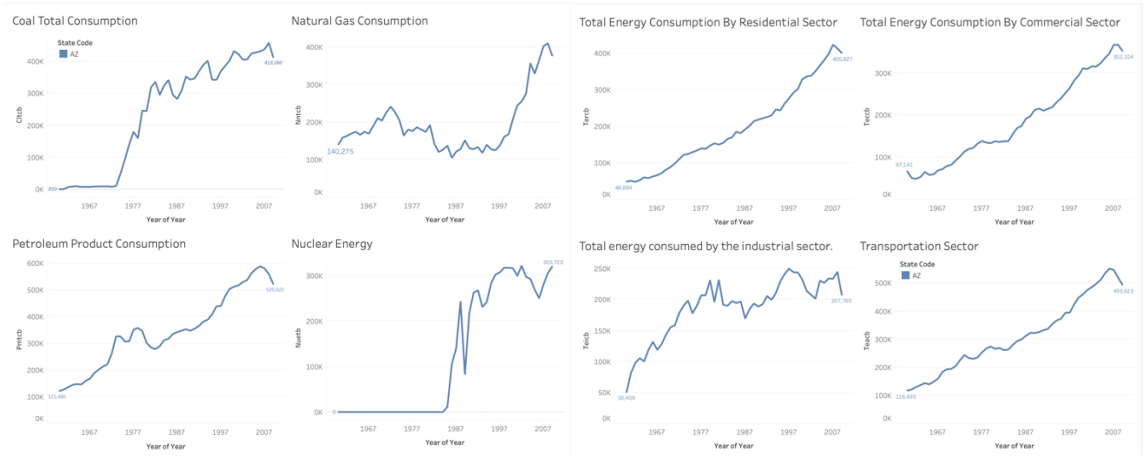
As we can see from graph, Texas has highest Residential and industrial Sector Consumption, whereas California has the highest Transportation Sector and Commercial Sector Consumption. The consumption for Arizona and New Mexico were almost negligible in comparison to other state.

Now, we do the analysis for each of the State.

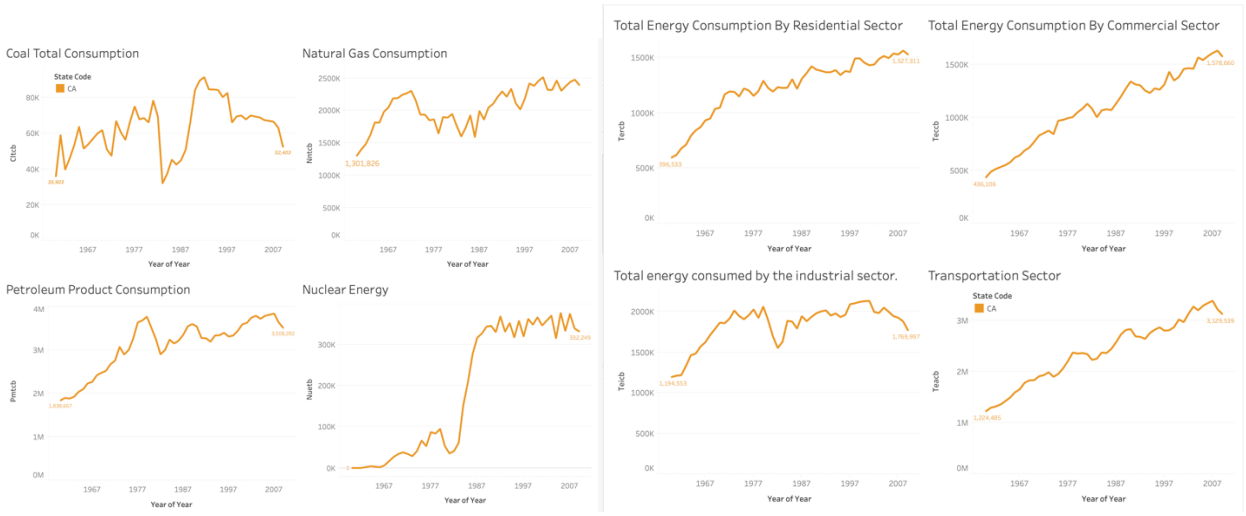
Arizona Profile



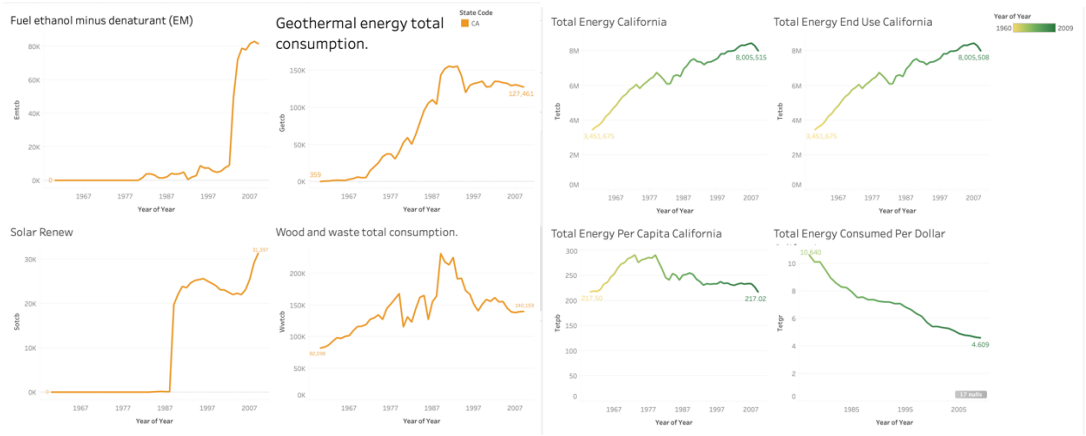
As we see from above, we see the distribution of various variable. The Total energy consumed, and total energy end use of Arizona is increasing from 1960 to 2009. The Total Coal consumption and Natural Gas Consumption goes up from 1960 to 2009. The Nuclear Energy Consumption increases rapidly from late 80's in Arizona. The industrial sector consumption is changing from year to year and we do see an increasing trend but not as clear trend as for another variable.

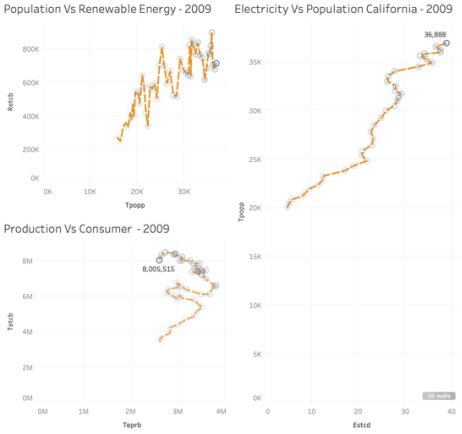


California Profile

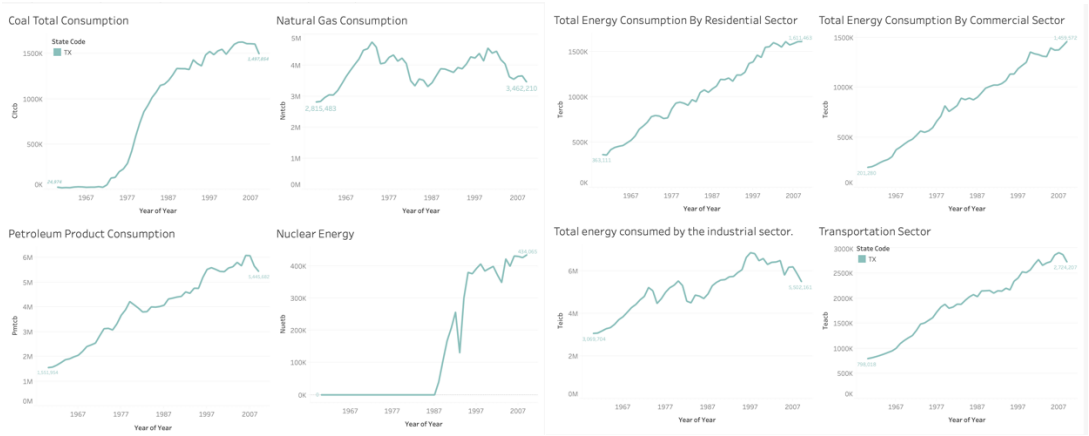


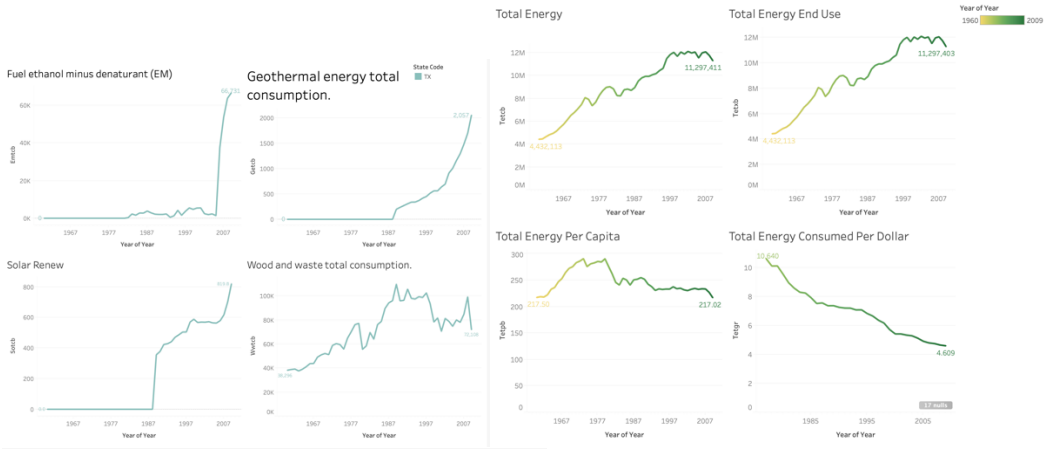
We see a similar trend for California as well. Nuclear Energy and Fuel ethanol has exponential growth from late 1970's and late 2000's respectively. The Solar energy data is not available till 1987. Therefore, we see an exponential increase from 1987.

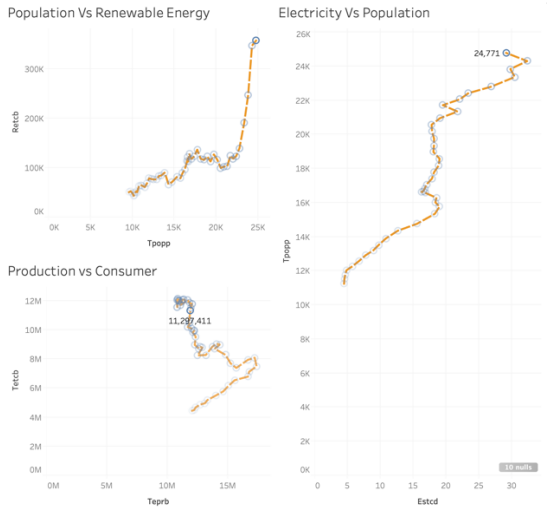




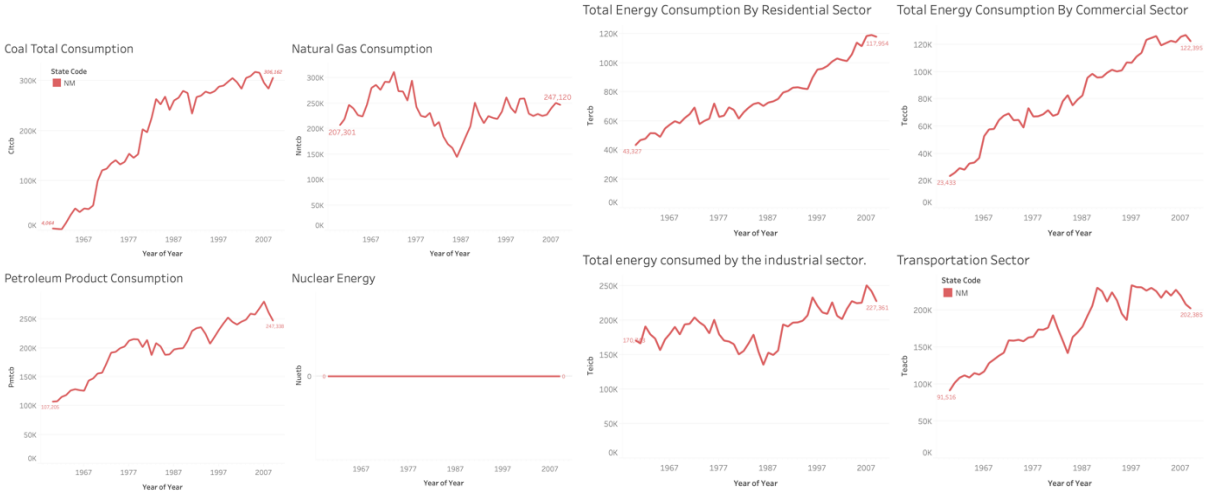
TEXAS PROFILE

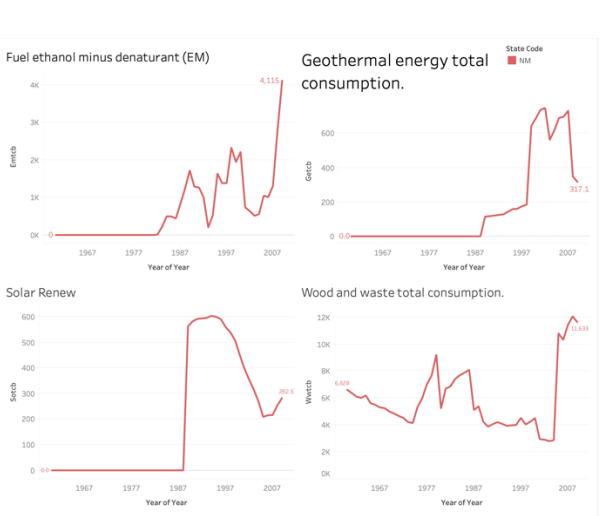


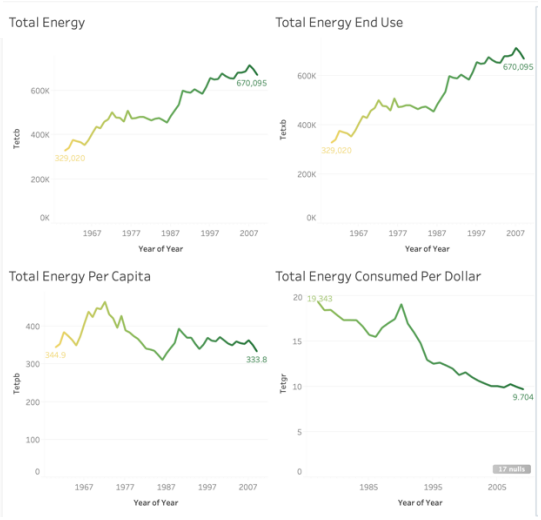


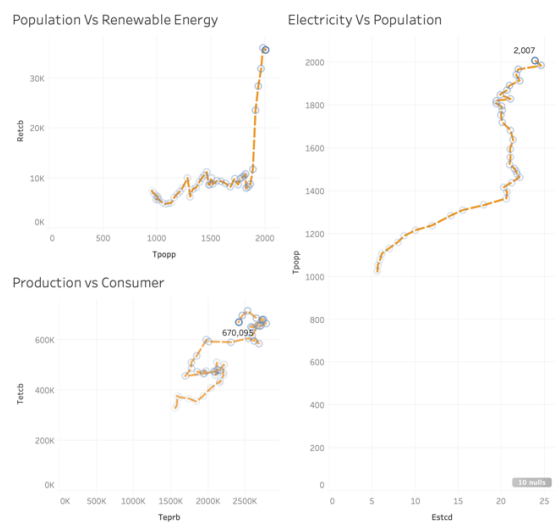


NEW MEXICO


Coal Total Consumption
Natural Gas Consumption
Total Energy Consumption By Residential Sector
Total Energy Consumption By Commercial Sector
Petroleum Product Consumption
Nuclear Energy
Total energy consumed by the industrial sector.
Transportation Sector
State Code
NM
Year of Year

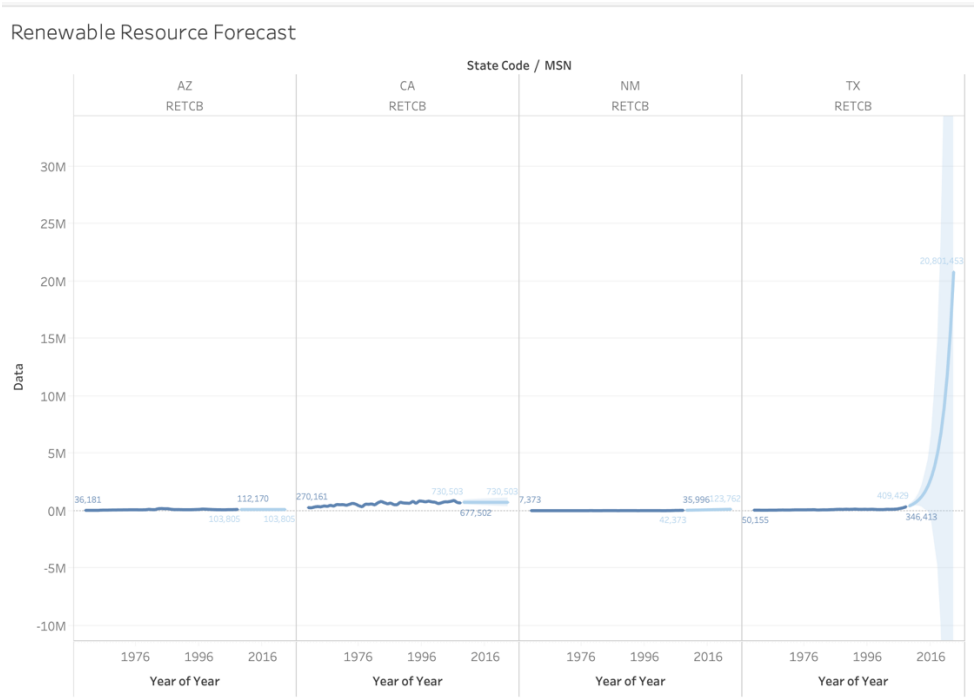

Fuel ethanol minus denaturant (EM)
Geothermal energy total consumption.
Solar Renew
Wood and waste total consumption.
State Code
NM
Year of Year


Total Energy
Total Energy End Use
Total Energy Per Capita
Total Energy Consumed Per Dollar
670,095
329,020
344.9
333.8
19.243
9.704
Year of Year

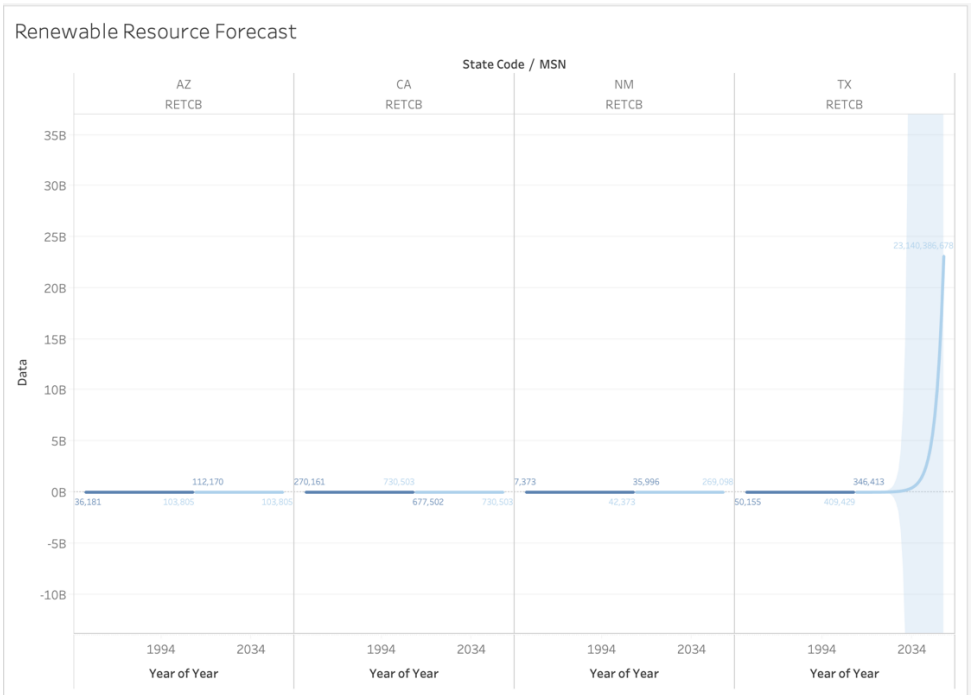

Population Vs Renewable Energy
Electricity Vs Population
Production vs Consumer
2,007
670,095
Tpopp
Teprb
Estcd

PREDICTION

- Renewable Forecast for 2025



- Renewable Forecast for 2050



As we see from above, RETCB is the most important variable to forecast the renewable energy consumption is each of the state. We consider RETCB as the main variable because it is sum of all the renewable energy sources combined.

The Action Plan for each of the State should be to cut on use of Non-renewable resources mainly in Texas. New Mexico and Arizona should invest more in Renewable resources in the years to come.

Since Renewable Energy is the way forward, we would encourage people to invest more in New Mexico and Arizona since there is a huge opportunity in these states.

LIMITATIONS AND FUTURE WORK

With 605 variables, we need to use Principal Component Analysis for feature elimination and feature reduction.

In the dataset provided to us, some of the way to calculate these variables changed in mid 1990's. So, we can't get an exact representation of data before 1990's and after 1990.

In the future, we would like to check the whole 605 variables in more detail and do a thorough analysis of data before building a model.

Also, we would have loved to get the data till 2019 in order to come up with a more concrete model for predicting the future.

CONCLUSION

Based on the analysis, we can come to the conclusion that California has the cleanest profile of all. They have low consumption of Non-Renewable resources and High Consumption of Renewable resources.

New Mexico and Arizona need more investment in Renewable Energy whereas Texas needs to cut into the use of Non- Renewable Resources and shift more towards Renewable Resources.

Also, Since the total energy consumption in New Mexico and Arizona is less, we would want the governor to explore a way to produce it in these states but sell it to different state which has got very high energy consumption.