PYNERGY

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Questions we found interesting along the way:

Over the last six years, how has renewable energy stacked up against nonrenewable energy in Colorado?

Based on historical information, what trends in usage do we foresee in the next six years?

What motivated us to choose these questions and topics?

Now where and how do you find data on renewable energy?

- Google … of course!

- This led to information from the EIA (Environmental Impact Assessment) website which had a very large API to scrape from

*We also found and API at Xcel energy that we requested to use to compare data, but ultimately were denied access

Data Exploration

- API has years of information from both renewable and nonrenewable energy sources
- Used the requests.get() function to import API, then viewed data using json() and json.dumps() functions
- After reviewing with json.dumps formatting, we were easily able to visualize the data and also plan which data to specifically use for our studies

Set the Scale; How do we measure energy generation

1 KWh ~ Can power Running a dishwasher (1,000-1,500 watts) for less than an hour

1 MWh = 1,000 KWh

1 MWh ~ Can toast 89,000 slices of bread, Or power the average american home for 1.2 months

1GWh =1,000 MWh

1GWh ~ Enough energy to power the demand of approx 750 homes at any given time

Cleanup

To narrow our API data down further, we utilized a for loop and the append () function to select the specific data our study required and add it to a list.

Created multiple data frames using the information compiled within each list. We were able to then write csv files specific to energy type & calendar year.

As a result of great efforts in cleaning and filtering our data, we were quick and efficient to plot and analyze our results!

```
#print results of the api request
print(json.dumps(response, indent = 4, sort_keys=True))
```


```
{
    "apiVersion": "2.1.4",
    "request": {
        "command": "/v2/total-energy/data/",
        "params": {
            "api_key": "[redacted]",
            "data": [
                "value"
            ],
            "end": 2021,
            "facets": {
                "msn": [
                    "RECCBUS",
                    "REEIBUS",
                    "REICBUS",
                    "REPRBUS",
                    "RERCBUS",
                    "RETCBUS"
                ]
            },
            "frequency": "annual",
            "length": 5000,
            "offset": 0,
            "sort": [
                {
                    "column": "period",
                    "direction": "desc"
                }
            ],
            "start": 2016
        }
    },
    "response": {
        "data": [
            {
                "msn": "REICBUS",
                "period": 2021,
                "seriesDescription": "Total Renewable Energy Consumed by the Industrial Secto
                "unit": "Trillion Btu",
                "value": 2384.421
            },
            {
                "msn": "REPRBUS",
                "period": 2021,
                "seriesDescription": "Total Renewable Energy Production in Trillion Btu",
                "unit": "Trillion Btu",
                "value": 12326.254
            },
            {
```

Cleaning Data from API Results

```
#lists to store the desired values
energy_type = []
period = []
value = []
unit = []
```

```
#populate the lists
for item in range(len(response['response']['data'])):
    energy_type.append(response['response']['data'][item]['seriesDescription'])
    period.append(response['response']['data'][item]['period'])
    value.append(response['response']['data'][item]['value'])
    unit.append(response['response']['data'][item]['unit'])
```

```
#create dataframe from these lists
energy = {
    'Period':period,
    'Energy Type': energy_type,
    'Value':value,
    'Unit': unit

}

energy_df = pd.DataFrame(energy)
```

After filtering the API data at the source, we used for loops to create a DataFrame with results for each source and overall usage specific to our analysis. We repeated this process for each energy source for accurate comparison.

Creating a CSV from the DataFrame

Period	Energy Type	Use	Unit
2016	estimated total solar	999.12099	thousand megawatthours
2017	estimated total solar	1485.13282	thousand megawatthours
2018	estimated total solar	1652.53998	thousand megawatthours
2019	estimated total solar	1851.65606	thousand megawatthours
2020	estimated total solar	2204.37961	thousand megawatthours
2021	estimated total solar	2786.11122	thousand megawatthours

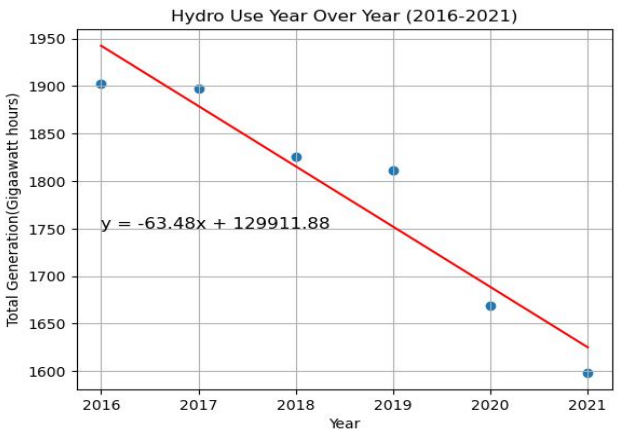
We created csv files for each of the energy sources analyzed for the years under review. These filtered csv files allowed for ease in creating visualizations of the results.

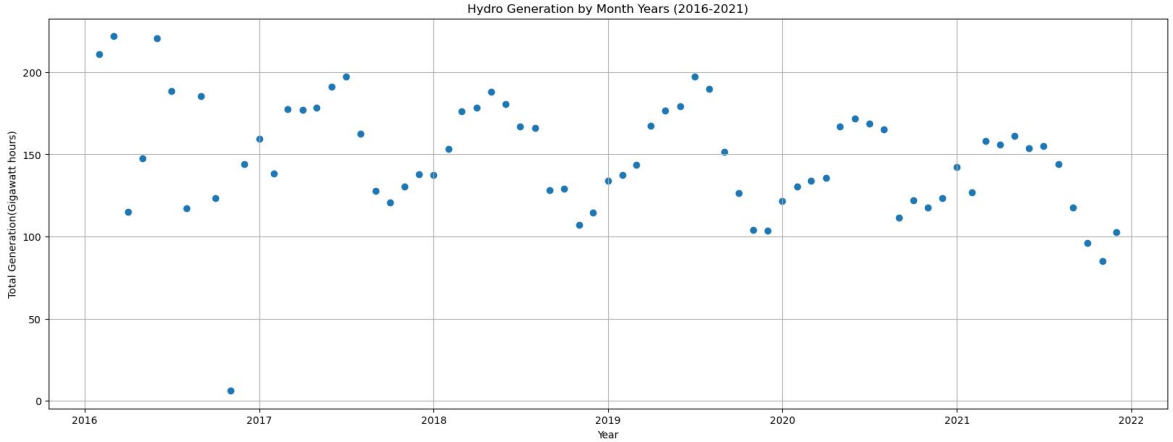
Analysis Process

- We used the data we cleaned and made regression models and used the r value to find if there were any correlation in our energy sources
- We also used the month over month data to determine seasonal trending year by year for the renewable energy sources
- We then took our data and projected models of 6 more years into the future for the reviewed energy sources

Visualizations of our Results…

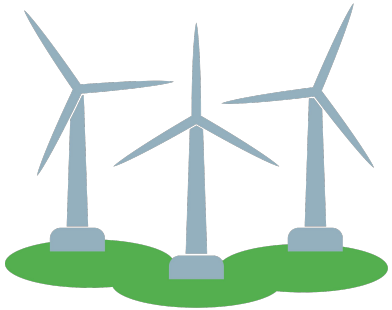
Hydroelectric use in Colorado has declined steadily on average over the last 6 years. It has the smallest percentage of use of the three larger renewable energy sources in Colorado.



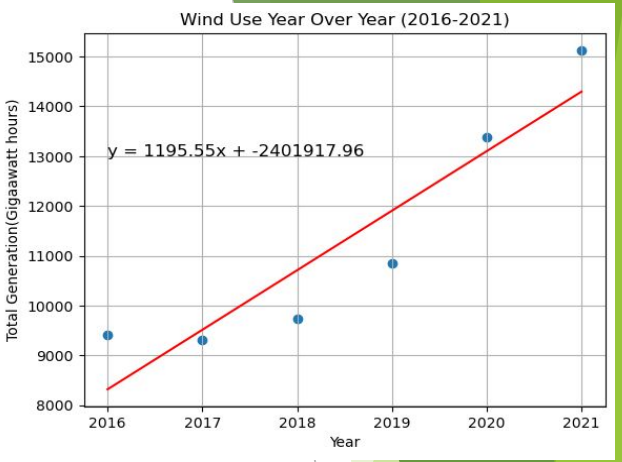


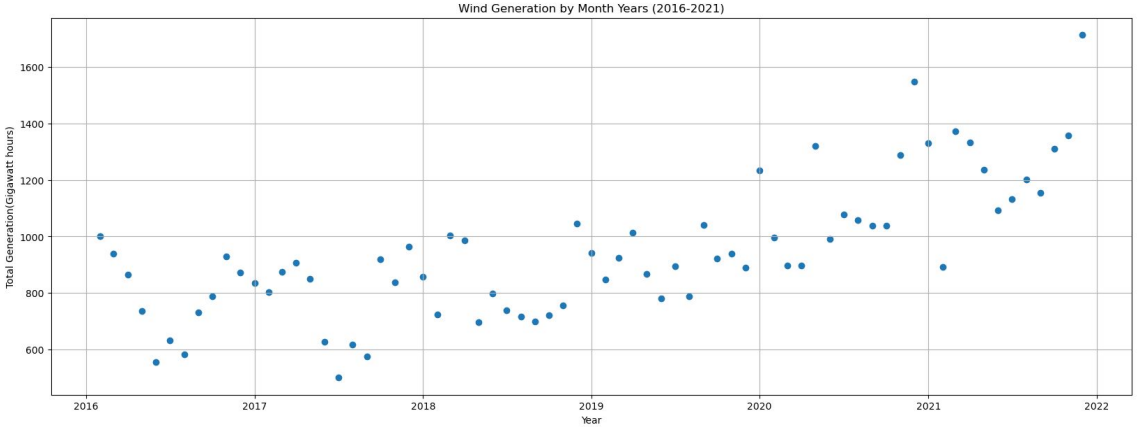
In a review of the hydroelectric use month over month, the usage increases through the early months of the year with a drop off generally in mid to late summer. This may be based on the seasonality of the energy source in Colorado based on climate.

Visualizations of our Results…



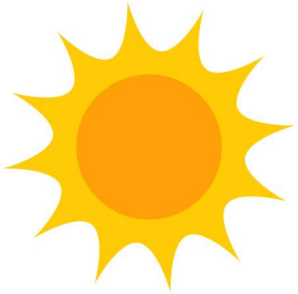
Wind power is the largest renewable energy source in Colorado. Its use continues to grow year over year with no indication of waning.



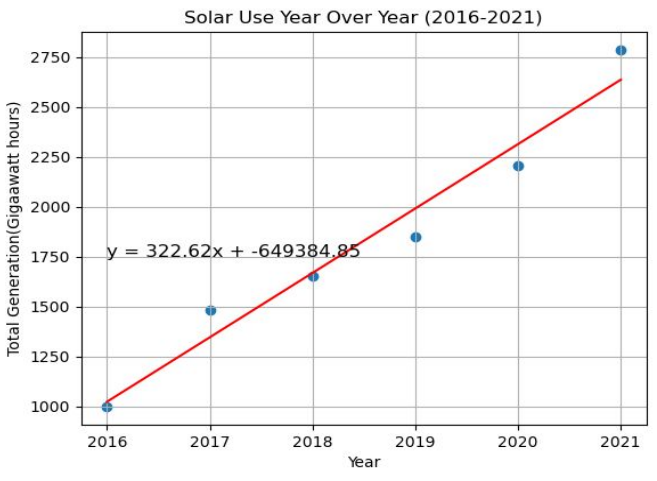


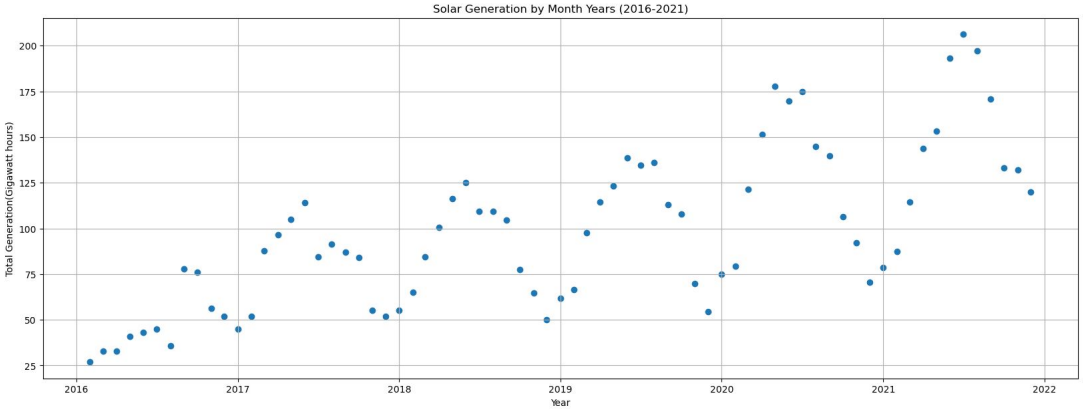
Wind has a usage pattern distinct from hydroelectric, as it sees a decline over the spring to summer months while usage increases in fall and winter. This may again be based on Colorado's changing seasons and weather patterns.

Visualizations of our Results…



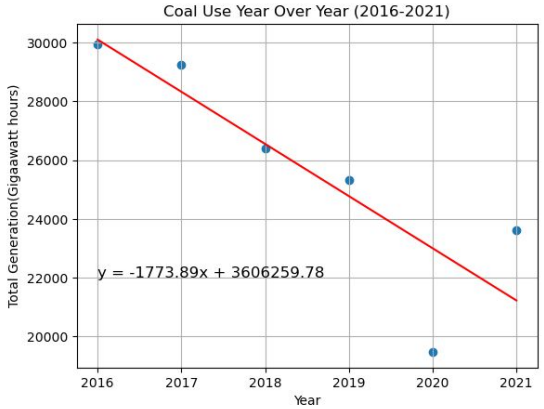
Solar power has shown a steady increase over the last 6 years in Colorado. There was a large increase between 2020 and 2021 possibly indicating that this energy source will continue to grow as a viable source for years to come.

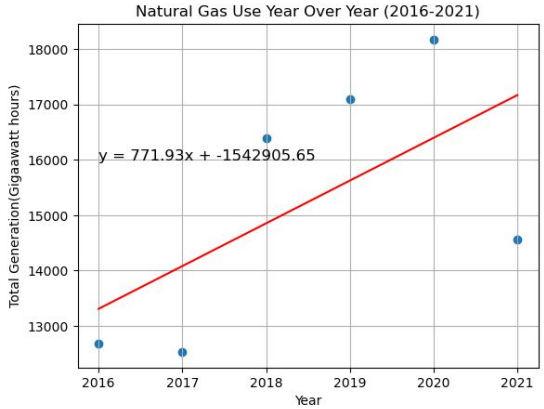




As with the other two reviewed renewable energy sources, solar usage is based on season trends month over month in Colorado. Solar usage increase through the spring and summer months with a sharp decline in the fall. Because solar has a smaller percentage of total renewable use, the variations month over month appear much larger than the other sources.

Visualizations of our Results…

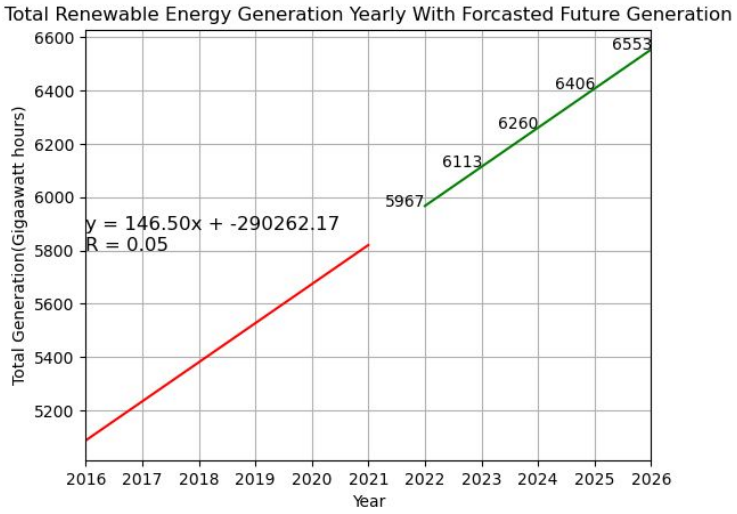


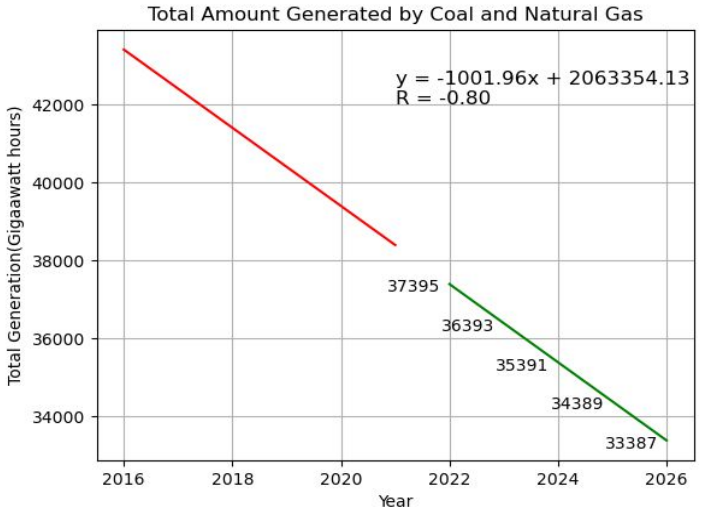


As energy generated from coal continues to decrease over time, it seems natural gas continues increase.

The decline of energy generated from coal is more drastic than the climb of energy produced from natural gas.

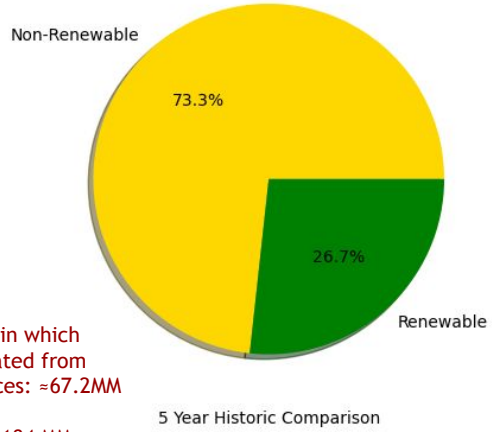
Future Modeling Based on History





We were able to create two charts comparing expected future use based on prior years usage for the renewable sources reviewed in comparison to the non-renewable sources. Even though non-renewable has a much larger share of usage, it appears to be on the decline, based on our findings.

Future Modeling Based on History



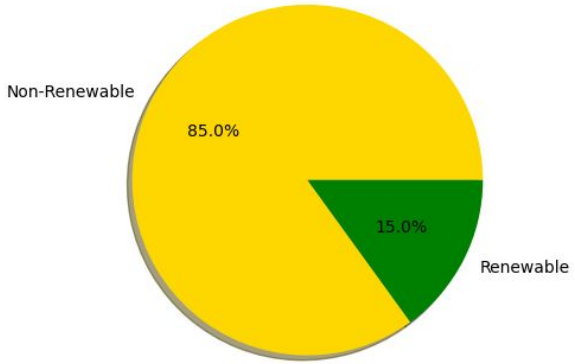
5 Year Historic Comparison

HISTORY
Amount of homes in which energy can generated from renewable resources: ≈67.2MM

Non-Renewable: ≈184 MM

FUTURE STATE
Amount of homes in which energy can generated from renewable resources: ≈23.5 MM

Non-Renewable: ≈133 MM



5 Year Future Comparison

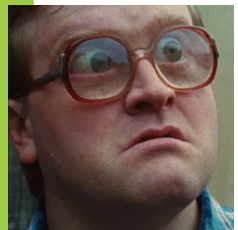
We can state generation of renewable energy will increase over time as non renewable decreases, however we project that energy generated from non renewable sources will account for even a bigger percentage in the future.

Summary and Conclusions

- We were able to find results for the questions we asked and we saw that renewable energy use has increased over the last 6 years on average while on average nonrenewable energy has decreased
- Though wind and solar usages increased, we did find that hydro usage has actually decreased over the last 6 years showing a continuous decrease
- Natural gas use still continues to be the energy source mostly used, though in 2021 and future projects showing that trend may change as renewable energy continues to gain traction
- Due to the recent increase in natural gas, our future modeling shows that renewable energy will account for a less percentage of total energy over the next 6 years. The increase in natural gas use is greater than the increase in renewable energy

Numerical Summary

- Most of our data was collected in different quantity types, so for transparency we wanted to show all of our data in gigawatt hours which to us was easier to read than Trillion BTU's. This was a conversion of 1 Trillion BTU's is equivalent to 293.0710701 gigawatt hours
- According to the numbers, we had a positive correlation between time and renewable energy of an r value of 0.94 while we had a negative correlation between time nonrenewable energy with an r value of -0.80
- Comparing the mean between renewable and nonrenewable we see that over the course of the last 6 years, renewable consumption was sitting at 11,344.57 gigawatt hours while nonrenewable was around 40,902.04 gigawatt hours



More numbers!

- Next we compared the median between renewable and nonrenewable energy and we found that renewable energy was at 11,419 gigawatt hours and nonrenewable energy was 41,330 gigawatt hours

- Comparing the top nonrenewable energy (natural gas) and the top renewable energy (wind), we see quite a difference in production. Natural gas over the last 6 years has a max production of 18,171 and gigawatt hours while wind only had a max of 15,125 gigawatt hours

What do our findings mean?

- Colorado as a whole is starting to increase renewable energy use more and in correlation nonrenewable energy has started to decrease
- Natural gas still reigns king, but there are possible trends to show this could be reversing
- We have more questions we can start asking such as: What is the reason for a decrease in hydro use in Colorado? Do the trends of renewable and nonrenewable energy continue across the United States as it does in Colorado? What other factors may contribute to the rise and fall of certain energy uses?

Thank you!

… may we get a  ?