**Project Title:**

Renewable energy production and consumption impact on fossil fuel prices and emissions.

How did U.S. policy or geo-political events impact those changes?

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**Project Description/Outline**:

Using the U.S. Energy Information Administration API we’ll analyze fossil fuel prices over time. We’ll also compare renewable energy production and consumption over the same period and how increasing use of renewable sources affects fossil fuel prices and CO2 emissions.

**Research Questions to answer:**

How have fossil fuel prices changed over time?

How has renewable energy production and consumption changed over time?

How has CO2 emissions changed over time?

Is there a correlation between increasing renewable energy production and consumption and fossil fuel prices?

Does increasing renewable energy production and consumption reduce total CO2 emissions?

How does does consumption of renewable or fossil fuel energy break down in relation to sector (i.e. industrial/commercial and residential)

**Data Sets to be used:**

We will be analyzing various data sets as provided by the Energy Information Administration on an annual basis. Our data sets are broken down by Petroleum, Natural Gas, Coal (to be further categorized by Fossil Fuels) Renewable Energy, and the environmental impact displayed between the two

<https://www.eia.gov/opendata/qb.php?category=829714>

1. **Nonrenewable/Fossil Fuel Data:**

**Price (for jeff: one graph 3 lines)**

**Natural Gas:** [**Natural Gas Henry Hub Spot Price ($/mmBtu), Annual**](https://www.eia.gov/opendata/qb.php?category=1039920&sdid=STEO.NGHHUUS.A)

**Petroleum:** [**West Texas Intermediate Crude Oil Price, Annual**](https://www.eia.gov/opendata/qb.php?category=1039852&sdid=STEO.WTIPUUS.A)

**Coal:** [**Cost of Coal Delivered to Electric Generating Plants, Annual**](https://www.eia.gov/opendata/qb.php?category=1039851&sdid=STEO.CLEUDUS.A)

*No Renewable Price data provided*

**Consumption (for Chris: one graph 3 lines)**

**Natural Gas:** [**US Natural Gas Consumption, Annual**](https://www.eia.gov/opendata/qb.php?category=1039914&sdid=STEO.NGTCPUS.A)

**Petroleum:** [**Total Petroleum and Other Liquids Product Supplied, Annual**](https://www.eia.gov/opendata/qb.php?category=829766&sdid=STEO.PATCPUSX.A)

**Coal:** [**Total Coal Supply, Annual**](https://www.eia.gov/opendata/qb.php?category=1039986&sdid=STEO.CLTSPUS_TON.A)

**Four types of Renewable Energy:** (**Consumption** measured in Btu)

[**Consumption of Conventional Hydroelectric Power Energy by All Sectors, Annual**](https://www.eia.gov/opendata/qb.php?category=1040012&sdid=STEO.HVTCBUS.A)

[**Consumption of Geothermal Energy by All Sectors, Annual**](https://www.eia.gov/opendata/qb.php?category=1040012&sdid=STEO.GETCBUS.A)

[**Consumption of Solar Energy by All Sectors, Annual**](https://www.eia.gov/opendata/qb.php?category=1040012&sdid=STEO.SOTCBUS.A)

[**Consumption of Wind Energy by All Sectors, Annual**](https://www.eia.gov/opendata/qb.php?category=1040012&sdid=STEO.WNTCBUS.A)

[**Total Consumption of Renewable Energy by All Sectors, Annual**](https://www.eia.gov/opendata/qb.php?category=1040012&sdid=STEO.RETCBUS.A)

**Supply (for Pavitra: one graph 3 lines)**

**Petroleum:** [**U.S. Crude Oil Production, Annual**](https://www.eia.gov/opendata/qb.php?category=829771&sdid=STEO.COPRPUS.A)

**Natural Gas:**

**Butane:** [**Butanes Production at Natural Gas Processing Plants, Annual**](https://www.eia.gov/opendata/qb.php?category=1039897&sdid=STEO.C4FPPUS.A)

**Ethane:** [**Ethane Production at Natural Gas Processing Plants, Annual**](https://www.eia.gov/opendata/qb.php?category=1039897&sdid=STEO.ETFPPUS.A)

**Propane:** [**Propane Production at Natural Gas Processing Plants, Annual**](https://www.eia.gov/opendata/qb.php?category=1039897&sdid=STEO.PRFPPUS.A)

**Coal:** [**Total Coal Supply, Annual**](https://www.eia.gov/opendata/qb.php?category=1039986&sdid=STEO.CLTSPUS_TON.A)

**Four types of Renewable Energy:** (**Supply/Capacity** measured in MW)

[**Electric Power Sector Conventional Hydroelectric Net Summer Capacity, Annual**](https://www.eia.gov/opendata/qb.php?category=2458746&sdid=STEO.HVEPCAP_US.A)

[**Electric Power Sector Geothermal Net Summer Capacity, Annual**](https://www.eia.gov/opendata/qb.php?category=2458746&sdid=STEO.GEEPCAP_US.A)

[**Electric Power Sector Large-Scale Solar Net Summer Capacity, Annual**](https://www.eia.gov/opendata/qb.php?category=2458746&sdid=STEO.SOEPCAPX_US.A)

[**Electric Power Sector Wind Net Summer Capacity, Annual**](https://www.eia.gov/opendata/qb.php?category=2458746&sdid=STEO.WNEPCAPX_US.A)

**Emissions: (for Jason) Measured in million metric tons**

**Petroleum:** [**Carbon Dioxide Emissions from Petroleum and Other Liquid Fuels, Annual**](https://www.eia.gov/opendata/qb.php?category=1039844&sdid=STEO.PATCCO2.A)

**Natural Gas:** [**Carbon Dioxide Emissions from Natural Gas, Annual**](https://www.eia.gov/opendata/qb.php?category=1039844&sdid=STEO.NGTCCO2.A)

**Coal:** [**Carbon Dioxide Emissions from Coal, Annual**](https://www.eia.gov/opendata/qb.php?category=1039844&sdid=STEO.CXTCCO2.A)

A little confused as to how there is a direct Fossil Fuel CO2 Emissions chart; perhaps the EIA already averaged emissions of Petroleum, Natural Gas and Coal. Anyway, here it is..

[**Carbon Dioxide Emissions from Fossil Fuels, Annual**](https://www.eia.gov/opendata/qb.php?category=1039844&sdid=STEO.FFTCCO2.A)

**Total CO2 Emissions:** [**Total Energy CO2 Emissions, Annual**](https://www.eia.gov/opendata/qb.php?category=1039844&sdid=STEO.TETCCO2.A)

**Rough breakdown of tasks:**

* Change date columns to be in a similar format
* Combine data, with dates as the common column
* Alpha = 0.05
* Hypothesis testing:
  + Ho: Renewable energy production and consumption does not affect fossil fuel price
  + Ha: Renewable energy production and consumption does affect fossil fuel price
* Do a regression analysis with renewable energy production and consumption as independent variables, and prices as the dependent variable.
* Same but with CO2 emissions as dependent variable.

**Intro:**

We wanted to get a better picture of U.S. energy production, consumption, carbon emissions, and energy prices. Overall, the U.S. has been increasing its energy production in both renewable energy sources and fossil fuels, with the exception of coal. We looked at a variety of data provided by the U.S. energy information administration API from 1990 until now. Total U.S. population has grown by about 30% over that same period which has likely had an impact on increasing energy production and consumption.

We wanted to know how energy production and consumption has changed over time. Has renewable energy production impacted consumption of fossil fuel? Has that impacted the price of fossil fuels? And how have carbon emissions changed over time as the U.S. changed its energy dependency on different sources.

What we’ve found is the U.S. has dramatically increased its production and consumption of wind and solar energy, but that didn’t cause too much disruption to fossil fuels, especially natural gas. Natural gas is considered to be the cleanest form of fossil fuels. The volatility of fossil fuels prices makes it difficult to determine if the production of renewable energy had any impact on fossil fuel prices. We also found that, as expected, carbon emissions from fossil fuels rises and falls with consumption of the same fuel types. But overall total carbon emissions are in a downward trend. However, we are producing more total carbon emissions than we were in 1990.We also found that as renewable energy production and consumption increased it did seem to decrease carbon emissions from fossil fuels with the exception of natural gas.

**Carbon emissions script:**

We looked at carbon emissions from petroleum, or crude oil, natural gas, coal, and total carbon emissions from 1990 until now. We also analyzed how consumption of fossil fuels and renewable energy impacts carbon emissions.

Total carbon emissions in the U.S. has been declining since 2007, although year to year the U.S. has increased total carbon emissions by .1% on average.

Carbon emissions from coal has been dramatically declining since 2008, but over the time period we looked at it still created the second most carbon emissions. Carbon emissions from petroleum makes up the largest amount.

The U.S. still relies heavily on petroleum and natural gas which you can see in the amount of carbon emissions they create and they’ve both been rising. Carbon emissions from natural gas has the most steady increase.

**Next slide:**

This is U.S. Carbon emissions from petroleum and other liquid fuels from 1990 until now.

You can see a pretty dramatic drop off from 2007-2009. I can’t say for certain why that is but you’ll see later that consumption of petroleum dropped during the same period. It’s possible this has something to do with the recession.

In 2007 it fell by 7% and then 5% the following year. It started rising again in 2012.

Overall the U.S. has increased carbon emissions from petroleum by 9.6% and .3% on average year to year.

It peaked in 2005 and 1991 saw the least amount of carbon emissions from petroleum.

**Next Slide:**

Here’s Carbon emissions from natural gas over the same period. You can see it’s been increasing pretty steadily since 2009.

Overall carbon emissions from natural gas have increased by almost 62% since 1990. And year over year it’s increased by 1.6% on average.

**Next slide:**

Here you can see the U.S. has been decreasing the amount of carbon emissions from coal since 2008. It peaked in 2005. And it fell the most in 2013 at a 13% decrease.

The U.S. has been decreasing it’s dependency on coal and this chart reflects that. Overall the country has decreased carbon emissions from coal by 39% since 1990. And it’s fallen by 1.4% year over year on average.

The president has said he wants to revive the coal industry, not much headway has been made there but it would be interesting to revisit this data in a few years to see if there has been any impact there.

**Next slide:**

Here’s total energy carbon emissions over the same period. To be clear this isn’t a sum of the previous data. This is a seperate data set from the U.S. energy information administration.

You can see total energy carbon emissions have been trending downward since 2007. But on average it’s increased by .1% year over year and currently the U.S. creates 2.8% more carbon emissions than it did in 1990.

It fell the most in 2009 by 7%.

**Next slide:**

Here’s total carbon emissions from each type of fossil fuel.

You can see petroleum creates the most carbon emissions in the U.S. It makes up almost 43% of carbon emissions from fossil fuels.

You can also see that despite decreasing carbon emissions from coal it still makes up the second most carbon dioxide emissions over the time period. Likely due to coal being one of the dirtiest forms of energy. It makes up 34% of carbon emissions in the U.S.

And despite the steady increase of carbon emissions from natural gas it makes up only 23% of carbon emissions from fossil fuels in the U.S.

**Next slide:**

Here’s a look at carbon emissions from fossil fuels compared to fossil fuel consumption. We had to normalize the values here for consumption and carbon emissions because they’re measured in different units. Consumption is shown with the dotted lines and carbon emissions is shown with the solid lines.

You can see there’s a pretty strong correlation between the amount of fossil fuels consumed and the carbon emissions created from those fuel types. As consumption rises or falls so does carbon emissions.

One interesting observation is carbon emissions from petroleum starts to deviate from consumption around 2008. Creating pretty drastically carbon emissions compared to consumption despite the trends staying parallel to each other.

Again I can’t say for certain what caused this. But it’s reasonable to assume that efforts by the energy department to invest in research and technology to make drilling for crude oil cleaner and more efficient could have contributed to that deviation.

**Next slide:**

Here’s a look at carbon emissions from fossil fuels compared to renewable energy consumption. Again we had to normalize the data because it’s measured in different units.

And again carbon emissions are the solid lines and renewable energy consumption are the dotted lines. The black line is geothermal consumption, green is wind energy, and brown is solar energy.

You can see as renewable energy consumption started to rise carbon emissions from fossil fuels eventually started to fall, with the exception of natural gas. And while carbon emissions from petroleum are rising again it’s still well below its peak in 2005.