

# U.S. Energy Analysis



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# Project Description/Outline:

## **What we analyzed:**

We are looking at the differences between Fossil Fuels and Renewable Energy in regards to the impact production and consumption have on U.S. prices and CO2 emissions.

## **Source we used:**

We utilized APIs within the ***U.S. Energy Information Administration*** database to analyze energy levels in regards to supply, consumption, price and emissions over time. We'll also compare renewable energy production and consumption over the same period and further note how increasing use of renewable sources affects fossil fuel prices and CO2 emissions.

## **Research Questions to answer:**

How has U.S. nonrenewable and renewable energy supply and consumption changed over time?

Has renewable energy had any influence on energy consumption?

How have CO2 emissions changed over time and what is their relationship between the two forms of energy?

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

How have fossil fuel prices changed over time?

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

# Why an energy study?

Energy sources vary across the U.S., so we wanted to look into whether or not these differences in energy types have an influence on one another.



General representation of where each fuel type is in relation to the United States.

## California Fact:

An increasing percentage of energy consumed by Californians comes from renewable sources.

California has worked to advance the procurement of eligible renewable energy resources (solar, wind, geothermal and small hydroelectric) to 33 percent of retail sales by 2020 and 60 percent of retail sales by 2030.



# Renewable vs Non-Renewable Sources

## What are Non-Renewable Energy Sources?

- ❖ Fossil fuel energy sources are non-renewable resources that formed when prehistoric plants and animals died and were gradually buried by layers of rock, examples include Oil, Coal, Natural Gas.



## What are Renewable Energy Sources?

- ❖ Renewable energy is energy from sources that are naturally replenishing but flow-limited. They are virtually inexhaustible in duration but limited in the amount of energy that is available per unit of time.

The major types of renewable energy sources are:

- ❖ Hydropower
- ❖ Geothermal
- ❖ Wind
- ❖ Solar
- ❖ Biomass

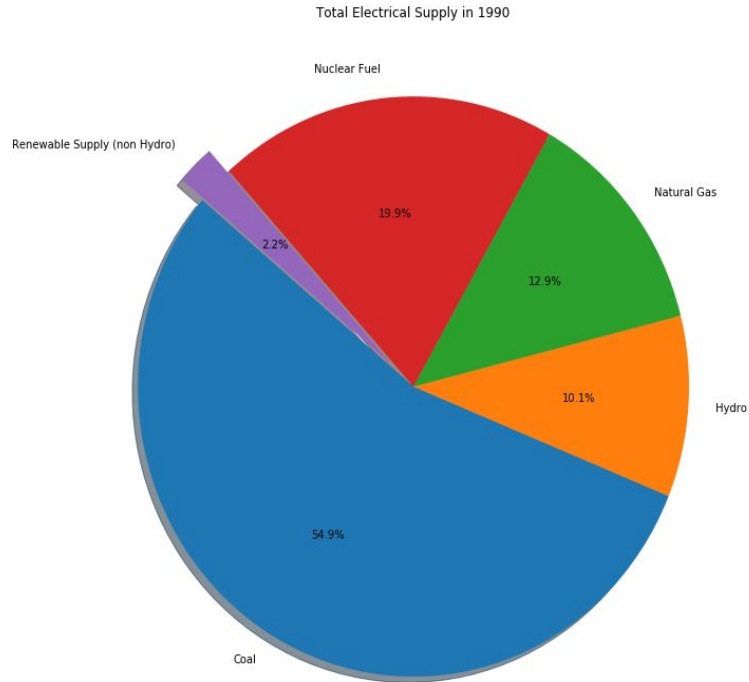


# Total Electrical Energy Supply

- ❖ Coal was major part of Electrical supply in 1990 with 54% of Total.
- ❖ Electrical Energy from Coal started to fall from year 2001 although 2007 has the most amount of total Coal generation with 5524.53 Mega Watts.
- ❖ Despite fossil fuels being discouraged, Natural Gas Production continues to increase. It increased by around 4 times from 1990 to 2020 with 1021.27 MW to 4167.18 MW.
- ❖ 2010 has the most amount of total Nuclear Fuel generation with 2210.87 Mega Watts.
- ❖ Total Renewable Supply Rose from 10.1 % in 1990 to 17% in 2020.



# Total Supply Of Electrical Energy



# Percent Change for Electric Energy



# Supply of Total Renewable Sources

- ❖ Electrical Generation from Total Renewable Supply including Hydro rose to 17% in 2020.
- ❖ Total non-Hydro Renewable supply of Electrical Energy rose from almost 0.1% to 6.6% in 2020.
- ❖ Renewable Supply increased 7 times from 1990 to 2020. 2020 being highest
- ❖ Hydro Power Generation remained almost same throughout 1990 to 2020. Only 3% difference between highest & lowest generation years
- ❖ Wind Power Generation increased 28 times from 2001 to 2020.
- ❖ Geo-Thermal Generation increased by 22% from 2003 to 2020.
- ❖ Solar Power Generation increased from 2001 to 2020 by 108 times





# US Renewable Supply for Electric Generation



# US Renewable Supply (Percent) Change



# U.S. Fossil Fuel Consumption:

Over the last thirty years, the U.S. has consumed the **total average** amounts:

**19.20** million barrels of produced/day

**21.04 MMbpd** projected in 2020.

**65.24** billion cubic feet/day

**83.56 bcf/day** projected in 2020.

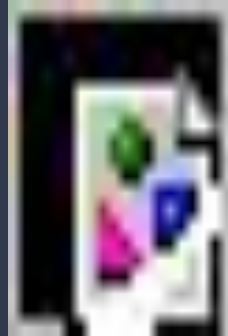
**955.73** million short tons

**599.214 MMst** projected in 2020.



# U.S. Renewable Energy Breakdown

Representation of each renewable energy form, measured in quadrillion btus (quads):



# U.S. Geothermal Consumption:

Geothermal energy was at its lowest consumption level in the US in **1995** with **0.152** quadrillion btu.

Geothermal energy will be at its highest consumption level in the US in **2020** with **0.231** quadrillion btu.

The largest percent increase in U.S. geothermal energy consumption was **7.43%** in 1996.

The largest percent decrease in U.S. geothermal energy consumption was **12.34%** in 1995.

By 2020, The U.S. will have consumed approximately **5.87 quadrillion btus** of geothermal energy since 1990.

Average Annual Growth Rate **1.05%**



# U.S. Solar Consumption:

Solar energy was at its lowest consumption level in the US in **1990** with **0.059 quadrillion btu.**

Solar energy will be at its highest consumption level in the US in **2020** with **1.274 quadrillion btu.**

The largest percent increase in U.S. geothermal energy consumption was **50.07%** in 2014.

The largest percent decrease in U.S. geothermal energy consumption was **3.46%** in 2000.

By 2020, The US will have consumed approximately **7.338 quadrillion btus** of solar energy since 1990.

Average Annual Growth Rate **1.13%**



# U.S. Wind Consumption:

Wind energy will be at its lowest consumption level in the US in **1990** with **0.029 quadrillion btu**.

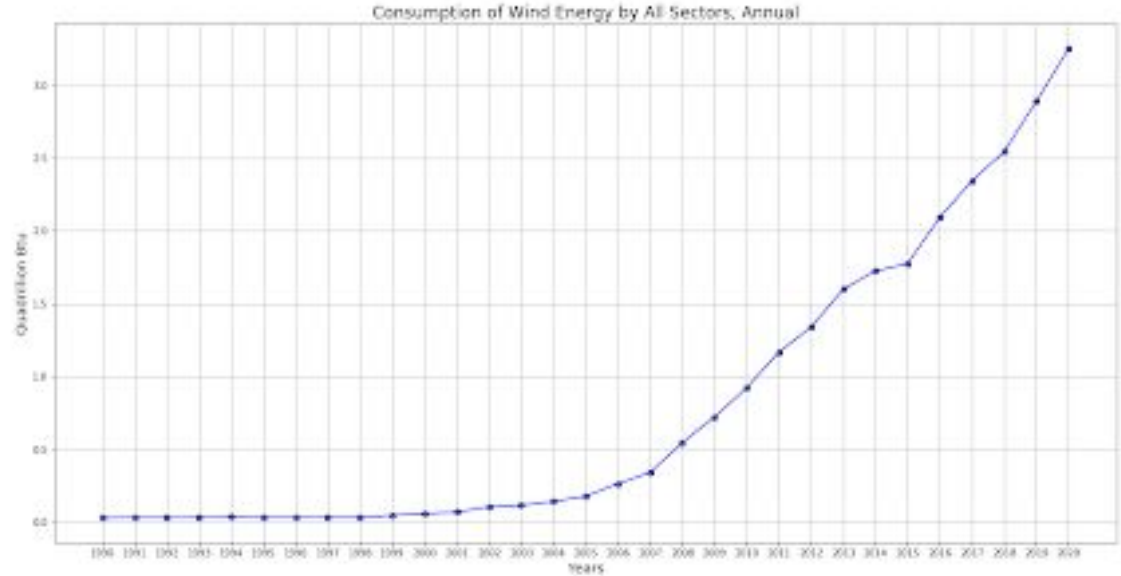
Wind energy was at its highest consumption level in the US in **2020** with **3.254 quadrillion btu**.

The largest percent increase in US geothermal energy consumption was **60.22%** in 2008.

The largest percent decrease in US geothermal energy consumption was **8.24%** in 1995.

By 2020, The US will have consumed approximately **24.532 quadrillion btus** of wind energy since 1990.

Average Annual Growth Rate **1.76%**



# U.S. Hydroelectric Consumption:

Hydroelectric energy was at its lowest consumption level in the U.S. in **2001** with **2.242 quadrillion btu.**

Hydroelectric energy was at its highest consumption level in the U.S. in **1997** with **3.641 quadrillion btu.**

The largest percent increase in U.S. hydroelectric energy consumption was **22.23%** in 2011.

The largest percent decrease in U.S. hydroelectric energy consumption was **20.25%** in 2001.

By 2020, The U.S. will have consumed approximately **86.27 quadrillion btus** of hydroelectric energy since 1990.

Average Annual Growth Rate **3.35%**





# Total Renewable Consumption:

Among these four renewable types of energy, the U.S. has consumed approximately **124 quadrillion btu** of total energy within the last 30 years alone.



# U.S. Carbon Emissions from Fossil Fuels



- ❖ Overall total carbon emissions have been declining since 2007
- ❖ Carbon emissions from natural gas and petroleum are still on the rise
- ❖ Carbon emissions from coal have had the most dramatic decline starting in 2008
- ❖ Most carbon emissions in the U.S. come from petroleum

# U.S. Carbon Emissions from Petroleum & other Liquid Fuels



- ❖ Overall the U.S. has increased emissions from petroleum by 9.6%
- ❖ On average emissions increased by .3% year to year
- ❖ Carbon emissions from petroleum in the U.S. peaked in 2005 (2,622 mmt)
- ❖ The least amount of carbon emissions from petroleum was in 1991 (2,130 mmt)
- ❖ Emissions fell by 7% in 2007
- ❖ 5% the following year
- ❖ Started rising again in 2012

# U.S. Carbon Emissions from Natural Gas



- ❖ Overall emissions from natural gas has increased in the U.S. by 61.9%
- ❖ On average carbon emissions from natural gas rose by 1.6% year to year.
- ❖ 2020 is projected to have the most emissions from natural gas (1,661 mmt)
- ❖ 1990 had the least amount of emissions (1,026 mmt)

# U.S. Carbon Emissions from Coal



- ❖ Overall emissions from coal in the U.S. decreased by 39%
- ❖ On average carbon emissions from coal fell by 1.4% year to year
- ❖ 2020 is projected to have the least amount of emissions from coal (1,109 mmt)
- ❖ Carbon emissions from coal peaked in 2005 (2,181 mmt)
- ❖ Coal emissions started to fall in 2008
- ❖ Emissions from coal fell the most in 2015 at 13%

# Total Carbon Emissions in the U.S.



- ❖ Overall total carbon emissions in the U.S. increased by 2.8%
- ❖ While total carbon emissions are falling on average total emissions increased slightly by .1% year to year
- ❖ Total emissions peaked in 2007 (6,020 mmt)
- ❖ The least amount of total emissions was in 1991 (4,992 mmt)
- ❖ Total emissions started falling in 2007
- ❖ Total emissions fell the most in 2009 at 7%

# U.S. Carbon Emissions by Type



- ❖ Petroleum accounts for almost 43% of carbon emissions in the U.S.
- ❖ Even with emissions from coal declining it still makes up the second most amount of carbon emissions at almost 34%
- ❖ Natural gas makes up 23% of carbon emissions in the U.S.

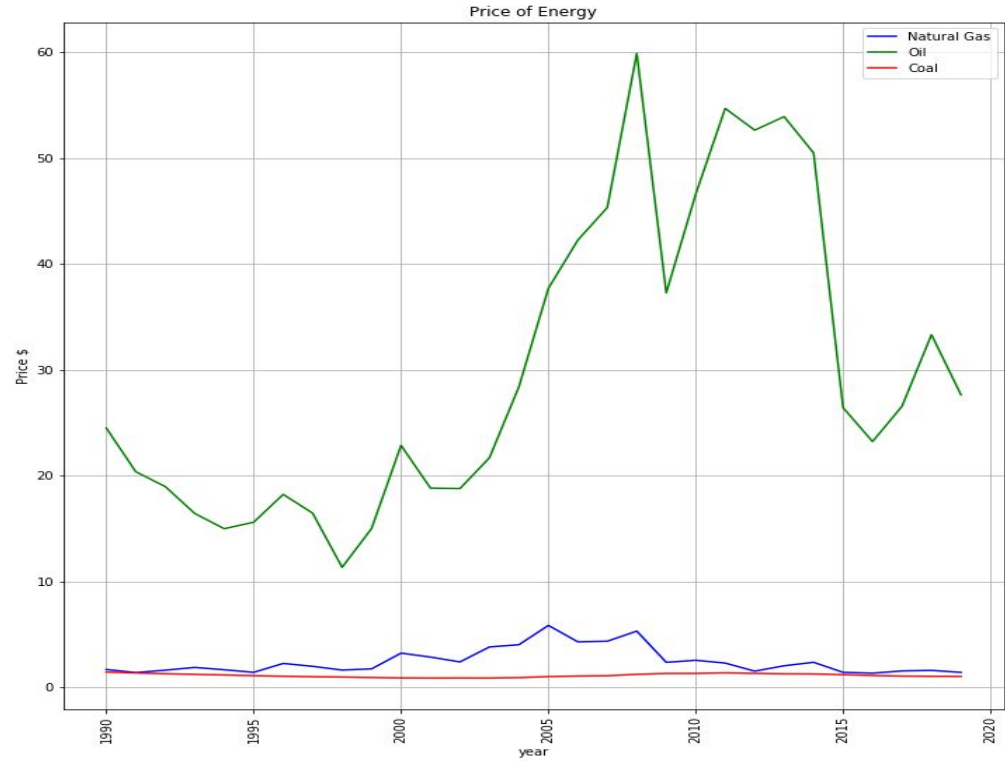
# Carbon Emissions and Fossil Fuel Consumption





# U.S. Carbon Emissions & Renewable Consumption





Comparing the price of energy to Fossil Fuel Consumption

# Price of Energy

- Oil
  - In 2003 we start seeing a rapid increase from \$31.40 to \$99.67 in 2008.
  - 2009 saw a sharp decrease to \$61.96/barrel but shot back up to \$94.8 in 2011.
  - 2015 saw a sharp decline in prices to \$48.66
  - Subtle increase to 65.06 in 2018,



# Individual Price Graphs



- There has been a massive increase in price of oil that has been steadily climbing since the year 2000, compared to coal and natural gas.
- Two spikes in Natural Gas in 2005 and 2008.
- Massive increase in Coal
  - Steady increase 200
  - Massive 2003



# Price Adjusted for Inflation



- When adjusted for inflation the pattern looks very similar, thus the spikes in oil and natural gas cannot be attributed to inflation.

# Percentage Change



# Conclusion:

We examined energy data within the U.S. dating back to 1990. We found that overtime, the fossil fuel and nonrenewable market was only slightly disrupted by renewable energy. The relationship between supply and consumption showed to be positive; as supply increased over time, consumption would follow.

Overtime, carbon emissions have demonstrated to follow in the footsteps of consumption. This demonstrates that as we consume energy we are simultaneously feeding our environment with CO2 emissions. Additionally, we found that 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.

We believe renewable energy production and consumption has reduced total CO2 emissions, as there is a negative relationship between the emission rates of coal and petroleum, while natural gas continues to demonstrate a positive correlation with renewables.

In regards to price, the fossil fuel market has demonstrated to have more volatility over time. We examined the price of each nonrenewable energy price over the last thirty years. We found there's a common trend with supply/consumption of the big three energy sources and the overall price in the market had a positive correlation with supply and consumption rates, with the exception of

# Work Cited:

- Weng-Gutierrez, Malachi. "California Energy Commission - Tracking Progress." *Energy.ca.gov*, California Energy Commission, Dec. 2018, [www.energy.ca.gov/renewables/tracking\\_progress/documents/renewable.pdf](http://www.energy.ca.gov/renewables/tracking_progress/documents/renewable.pdf).
- United States, Congress, E.I.A. "Short-Term Energy Outlook (STEO)." *Short-Term Energy Outlook (STEO)*, U.S. Energy Information Administration, 2019, pp. 1–49.
- U.S., D.O.E. "Fossil." *Department of Energy*, OAD, [www.energy.gov/science-innovation/energy-sources/fossil](http://www.energy.gov/science-innovation/energy-sources/fossil).



# Direct Links to APIs used:

## **Supply:**

Petroleum: [U.S. Crude Oil Production, All Sectors Generation from Petroleum \(All Types\), United States, Annual](#)

Natural Gas: [All Sectors Generation from Natural Gas, United States, Annual](#)

Coal: [All Sectors Generation from Coal, United States, Annual](#)

Nuclear: [All Sectors Generation from Nuclear, United States, Annual](#)

Hydroelectric: [Electric Power Sector Conventional Hydroelectric Net Summer Capacity, Annual](#)

Geothermal: [Electric Power Sector Geothermal Net Summer Capacity, Annual](#)

Solar: [Electric Power Sector Large-Scale Solar Net Summer Capacity, Annual](#)

Wind: [Electric Power Sector Wind Net Summer Capacity, Annual](#)

## **Emissions:**

Petroleum: [Carbon Dioxide Emissions from Petroleum and Other Liquid Fuels, Annual](#)

Natural Gas: [Carbon Dioxide Emissions from Natural Gas, Annual](#)

Coal: [Carbon Dioxide Emissions from Coal, Annual](#)

Fossil Fuels: [Carbon Dioxide Emissions from Fossil Fuels, Annual](#)

Total CO2 Emissions: [Total Energy CO2 Emissions, Annual](#)

## **Consumption:**

Natural Gas: [US Natural Gas Consumption, Annual](#)

Petroleum: [Total Petroleum and Other Liquids Product Supplied, Annual](#)

Coal: [Total Coal Supply, Annual](#)

Hydroelectric: [Consumption of Conventional Hydroelectric Power Energy by All Sectors, Annual](#)

Geothermal: [Consumption of Geothermal Energy by All Sectors, Annual](#)

Solar: [Consumption of Solar Energy by All Sectors, Annual](#)

Wind: [Consumption of Wind Energy by All Sectors, Annual](#)

Renewable: [Total Consumption of Renewable Energy by All Sectors, Annual](#)

## **Price**

Natural Gas: [Natural Gas Henry Hub Spot Price \(\\$/mmBtu\), Annual](#)

Petroleum: [West Texas Intermediate Crude Oil Price, Annual](#)

Coal: [Cost of Coal Delivered to Electric Generating Plants, Annual](#)