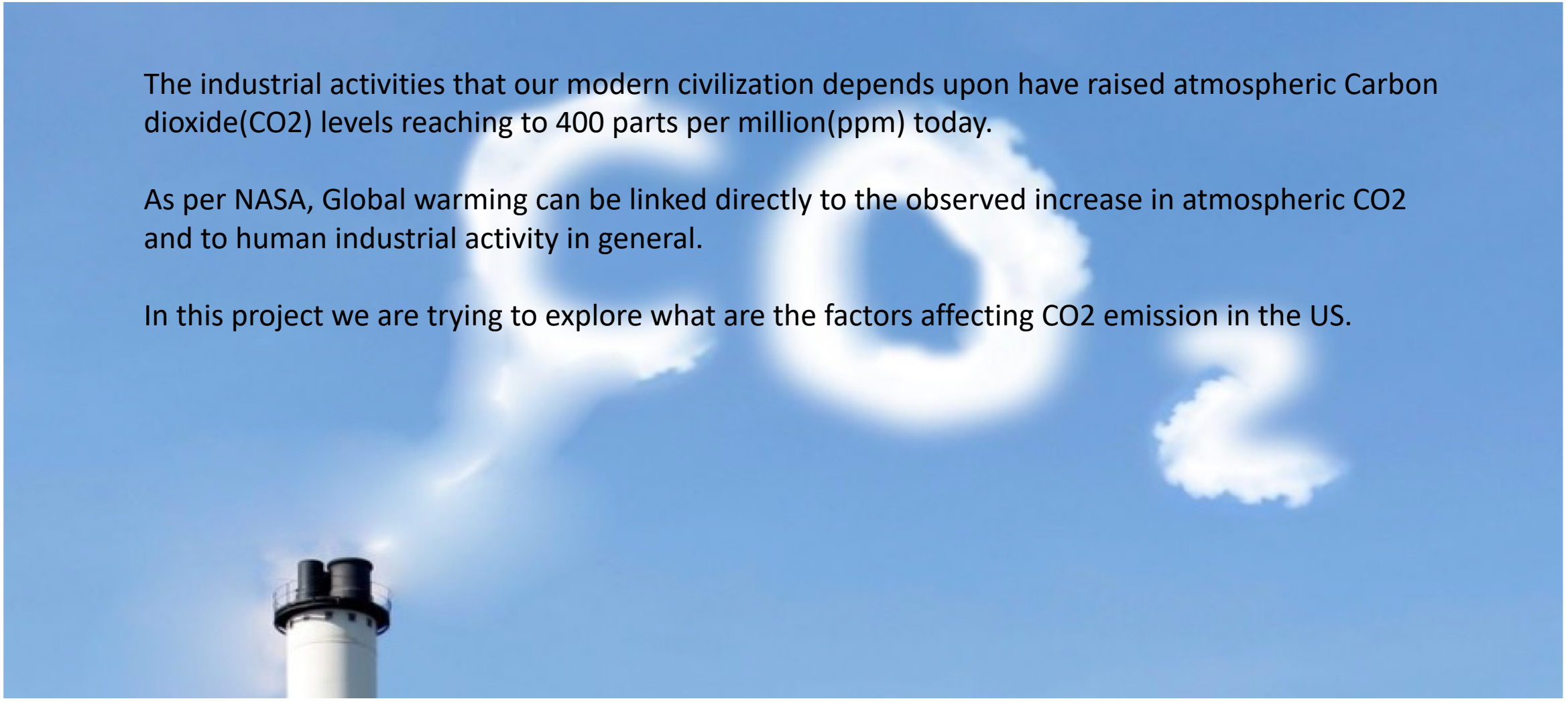
INTRODUCTION



The industrial activities that our modern civilization depends upon have raised atmospheric Carbon dioxide(CO_2) levels reaching to 400 parts per million(ppm) today.

As per NASA, Global warming can be linked directly to the observed increase in atmospheric CO_2 and to human industrial activity in general.

In this project we are trying to explore what are the factors affecting CO_2 emission in the US.

DATA SOURCE

- The datasets were pulled from the US Energy Information Administration's(EIA) website. The EIA is a government entity that collects, analyzes, and aggregates energy information within the United States as well as around the world.
- https://www.eia.gov/opendata/
- To explore the other possible causes of CO2 emission, we referred nature.com.

While exploring the EIA open data, we found out trends in how the total energy consumption has increased through the years and observed that there is a corresponding increase in CO2 emission. We called the EIA API and stored the data to CSVs using the code below.

```
#import Dependencies
import pandas as pd
import numpy as np
import requests
import json

#import API key
from config import api_key
from Serials import series_ids
```

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```
#declare variables
errors = []
url=f"http://api.eia.gov/series/?api_key={api_key}&series_id="
```

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```
#for loop to iterate through different api calls
for series_id in series_ids:
    try:
        #retrieve response
        response = requests.get(url + series_id).json()
        res = {'res_data': response['series'][0]['data']}

        #assign values to variables
        units = response['series'][0]['units']
        dataset_name = response['series'][0]['name']
        dataset_name = dataset_name.replace(' ', '_')
        dataset_name = dataset_name.replace('/', '-')
        #create df with cleaned data
        data_df=pd.DataFrame(res)
        data_df[['Year', units]]=pd.DataFrame(data_df.res_data.values.tolist(), index= data_df.index)
        cleaned_df = pd.DataFrame(data_df['res_data'].values.tolist(), columns=['Year', units])

        #export df to csv folder
        cleaned_df.to_csv('Data_new_2/' + dataset_name + '.csv', index = False, header = True)
    except KeyError:
        errors.append(series_id)
        continue
```

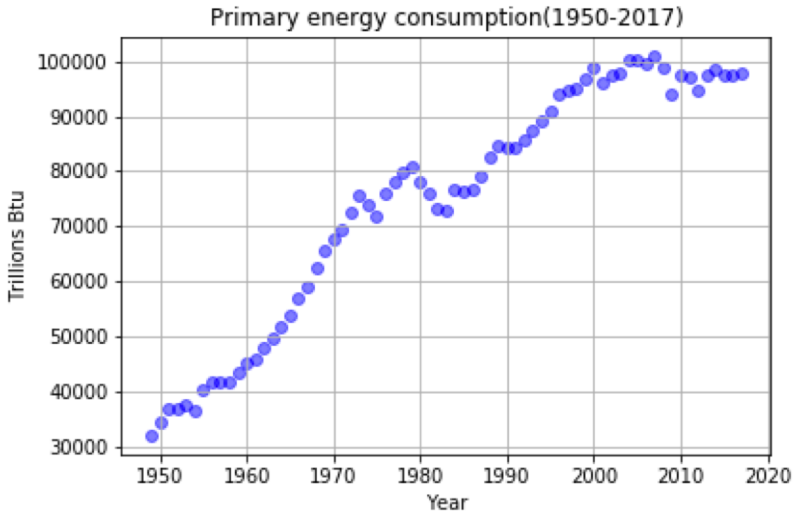
Next, we formed Data-Frames to get the CSV data is more readable format using the below code.

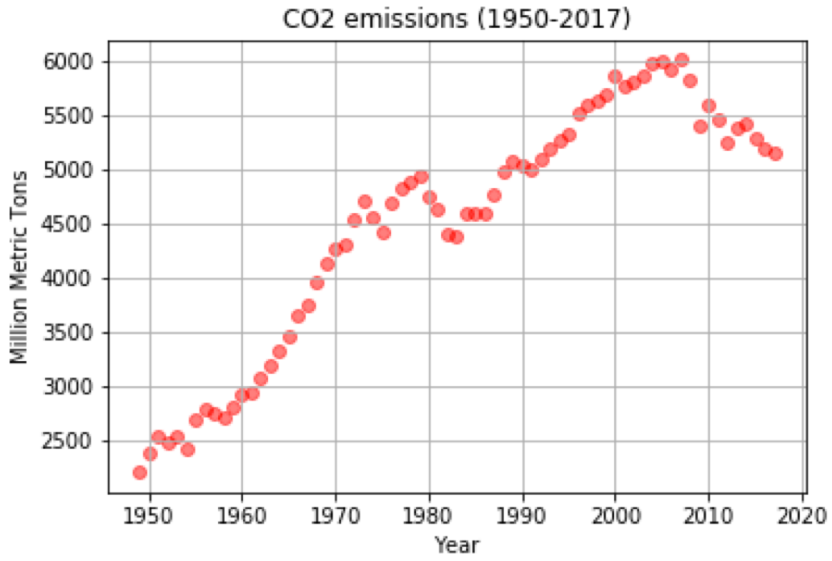
In [20]:
```
import pandas as pd
import os
import csv
from io import StringIO
import matplotlib.pyplot as plt
from os import path
```

In [33]:
```
dfs=[]
counter=0
for file in os.listdir('Data_new_2'):
    if file.endswith(".csv"):
        open_file=open('Data_new_2/' + file,'r')
        content = open_file.read()
        f = StringIO(content)
        reader = csv.reader(f, delimiter=',')
        arr = []
        for row in reader:
            arr.append(row)
        df=pd.DataFrame(arr)
        counter+=1
        print(f"data frame number: {counter}")
        print(file)
        print(df)
        dfs.append(df)
        continue
    else:
        continue
```

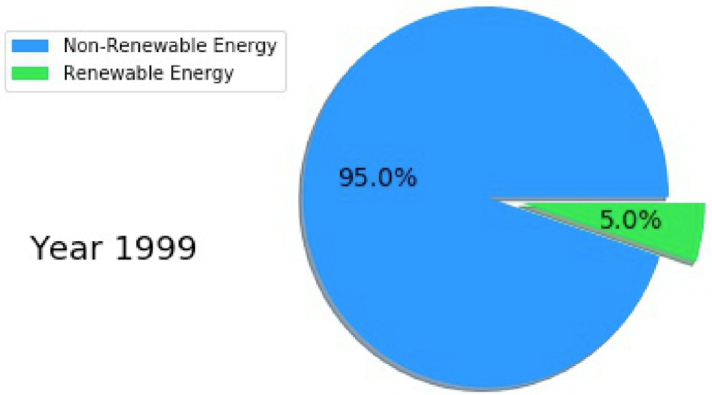
THE STORY:

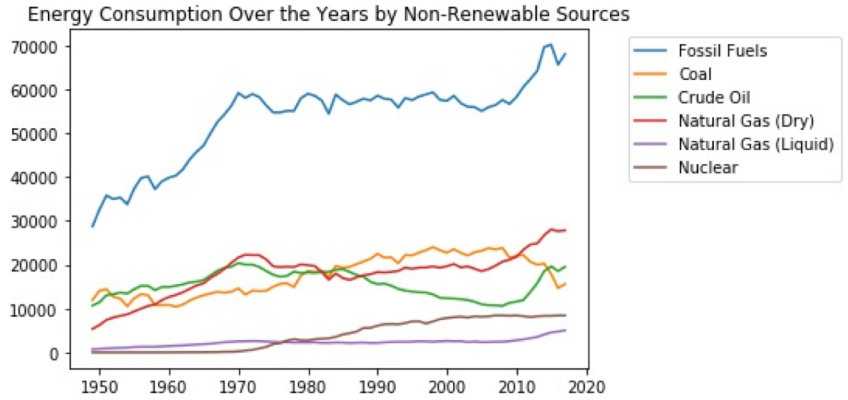
Energy consumption and CO2 emission trends-USA

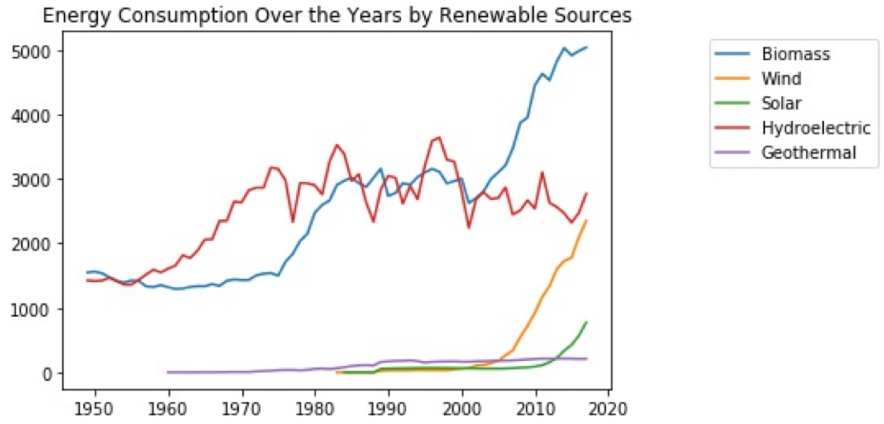




We saw that the total CO2 emission increased in the 2000s with an increase in total energy consumption







Renewable energy contribution has increased by 2.2% of total energy consumption since 1999 (USA) and there is a a corresponding reduction in CO2 emission.

That means use of renewable energy sources is helping us !

But to what extent??
Let's find out by analyzing the 2 trends statistically !!

```
In [1]: import warnings
        warnings.filterwarnings('ignore')

In [44]: %matplotlib inline
         from matplotlib import pyplot as plt
         import numpy as np
         import scipy.stats as stats
         import pandas as pd
         from scipy.stats.stats import pearsonr

In [45]: CO2Data = pd.read_csv("Data_new_2/Total_Energy_CO2_Emissions,_Annual.csv")
         RenewableData = pd.read_csv("Data_new_2/Total_Consumption_of_Renewable_Energy_by_All_Sectors,_Annual.csv")

In [46]: renewable = RenewableData['Quadrillion Btu'][2:].tolist()
         CO2=CO2Data['Million Metric Tons of Carbon Dioxide'][0:17].tolist()

In [48]: pearsonr(renewable, CO2)
Out[48]: (-0.898974038014074, 9.314630606172467e-07)
```

Here, Pearson coefficient ρ = -0.89 implies that $(-0.89^2)*100$ = **80% of variation in *CO2* emission can be explained by the change in renewable energy usage.**

The second value is the p value that describes the strength of evidence for whether *X* and *Y* are related at all. Here the p value is << 0.05 that means the strength of the evidence is strong.

What are the rest 20% contribution factors?

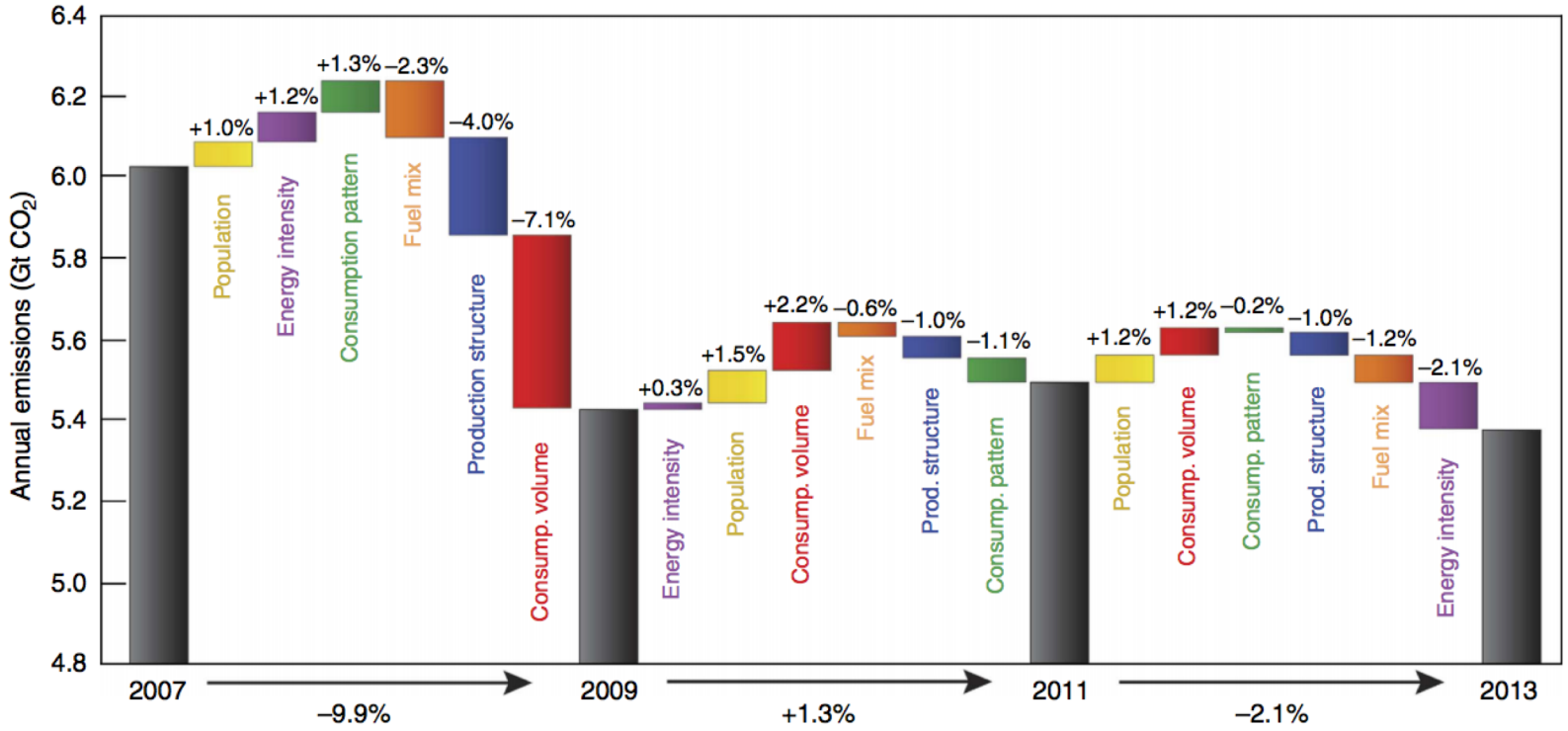
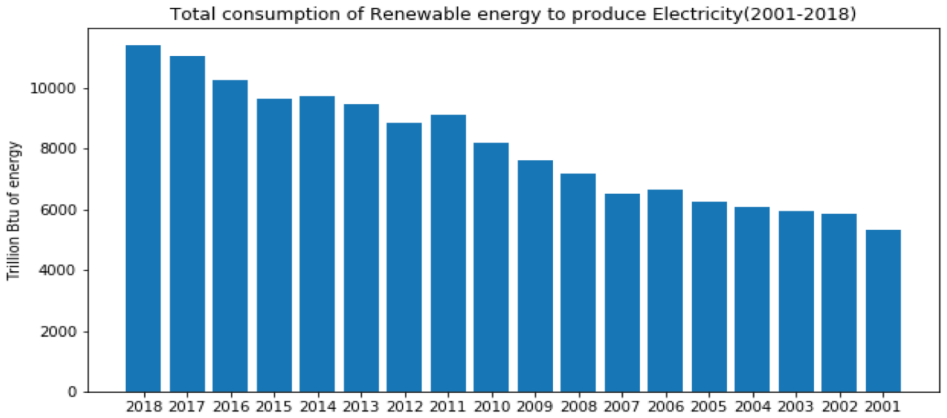
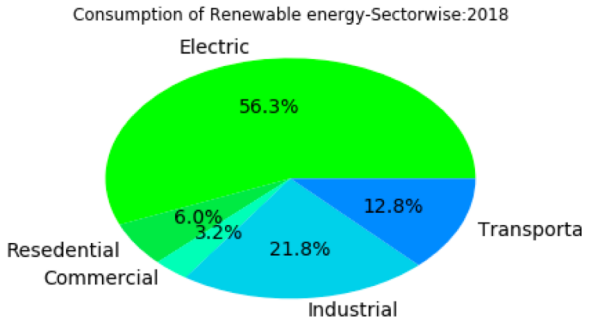
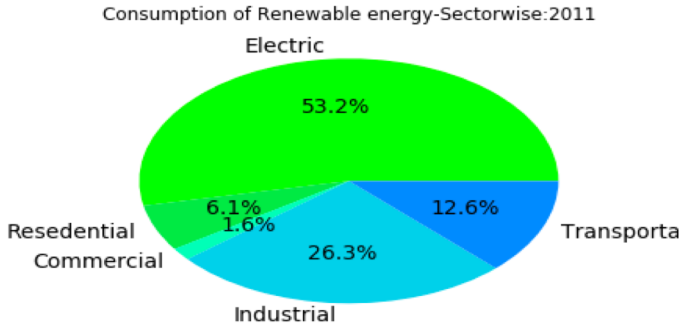


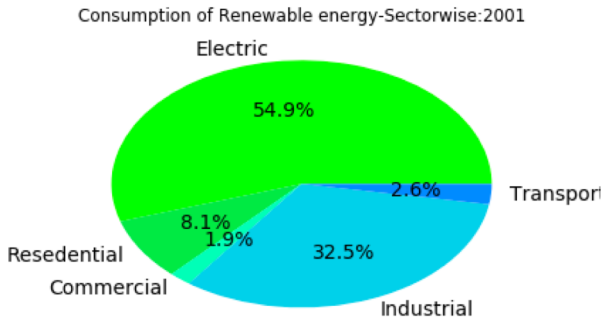
Figure 3 | Contributions of different factors to the decline in US CO_2 emissions 2007–2009 and 2009–2011 and 2011–2013. Between 2007 and 2009, decreases in the volume of goods and services consumed during the economic recession (red) was the primary contributor to the nearly 10% drop in emissions. But between 2009 and 2011, consumption (consump.) volume rebounded, population grew and the energy intensity of output increased, driving up emissions by 1.3% against modest decreases in the carbon intensity of the fuel mix and shifts in production structure and consumption patterns. Between 2011 and 2013, increases in population and consumption volume again pushed emissions upward, but overall emissions decreased by 2.1% due to further changes in production (prod.) structure, consumption patterns, decreasing use of coal and decreases in energy intensity of output. Not shown here, emissions increased by 1.7% between 2012 and 2013, driven primarily by increases in consumption volume. **(The above figure is with Courtsey to nature.com)**

Below graphs represent Renewable energy consumption sector-wise(Residential, Transportation, Commercial, Industrial and electric) in USA:









So it’s not just the government who can work to reduce the emission. 20% of the emission control is in our hands. What we can do?

- Save energy around the house.

- Use compact bulbs that use lesser energy.

- Save fuel by car pooling.

- Reduce consumption of goods by buying only what you need.